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OSTEOMYELITIS OF FRONTAL BONE RESULTING FROM EXTENSION OF SUPPURATION OF FRONTAL SINUS

SURGICAL TREATMENT

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The development of unsightly scars as a result of improper management of suppurative frontal sinusitis and osteomyelitis of the frontal bone [1] and the development of abscesses [2] of the brain as a result of inadequate treatment of these two conditions have prompted us to employ the surgical procedure presented here. It is obvious that early drainage of a suppurating frontal sinus will preclude extension of the infection to the frontal bone and the brain. Although the infection is usually attributable to Staphylococcus pyogenes-aureus, it may be extremely virulent and involve the diploic channels and the emissary veins of the skull within forty-eight hours. Therefore, the procedure we present is advantageous in preventing the usual deformity that follows an operation on the frontal sinus and permits the removal of all sequestrums and thorough drainage of the frontal sinus by removing the posterior table of the sinus.

ANATOMY

In order to describe the relationship of the diploic spaces to the diploe and the emissary veins, we believe it is worth while to quote from Gray's [3] "Anatomy of the Human Body":

> The diploic spaces of the cranial bones in the adult contain a number of tortuous canals, the diploic canals (canales diploici Brescheti), which are surrounded by a more or less complete layer of osseous tissue. The veins they contain are

From the Section on Neurologic Surgery and the Section on Otolaryngology of the Mayo Clinic.

1. Adson, A. W.: The Surgical Treatment of Gummatous Osteitis of the Skull, J. A. M. A. **74**:385-387 (Feb. 7) 1920; Surgical Treatment of Osteomyelitis of the Skull, West. J. Surg. **41**:65-77 (Feb.) 1933. Craig, W. M.: Multiple Tumors of the Skull Simulating Osteomyelitis, Arch. Neurol. & Psychiat. **26**:393-396 (Aug.) 1931.

2. Adson, A. W., and Craig, W. M.: The Surgical Management of Brain Abscess, Ann. Surg. **101**:7-26 (Jan.) 1935.

3. Gray, Henry: Anatomy of the Human Body, ed. 18, Philadelphia, Lea & Febiger, 1910, pp. 720-721 and 730.

large and capacious, their walls being thin and formed only of endothelium resting on a layer of elastic tissue; they present at irregular intervals pouch-like dilatations, or cul-de-sacs, which serve as reservoirs for the blood.

In adult life, so long as the cranial bones are distinct and separable, these veins are confined to the particular bones; but in old age, when the sutures are united, they communicate with one another and increase in size. They communicate, in the interior of the cranium, with the veins and sinuses of the dura, and on the exterior of the skull with the veins of the pericranium. They consist of (1) the frontal diploic vein (v. diploica frontalis), which opens into the supraorbital veins by an aperture in the supraorbital notch; (2) the anterior temporal diploic vein (v. diploica temporalis anterior), which is confined chiefly to the frontal bone, and opens into one of the deep temporal veins through an aperture in the greater wing of the sphenoid; (3) the posterior temporal vein (v. diploica temporalis posterior), which is situated in the parietal bone, and terminates in the lateral sinus through an aperture at the postero-inferior angle of the parietal bone or through the mastoid foramen; and (4) the occipital diploic vein (v. diploica occipitalis), the largest of the four, which is confined to the occipital bone, and opens into the lateral sinus or the torcular Herophili.

The emissary veins (emissaria) are vessels which pass through apertures in the cranial wall and establish communications between the sinuses inside the skull and the diploic veins in the diploe, and the veins external to the skull. Some of these are always present, others only occasionally so. They vary much in size in different individuals. The principal emissary veins are the following: (1) A vein (emissarium mastoideum), almost always present, runs through the mastoid foramen and connects the lateral sinus with the posterior auricular or with the occipital vein. (2) A vein (emissarium parietale) which passes through the parietal foramen and connects the superior sagittal sinus with the veins of the scalp. (3) A plexus of minute veins (rete canalis hypoglossi), which passes through the anterior condylar (hypoglossal) foramen and connects the occipital sinus with the vertebral vein and deep veins of the neck. (4) An inconstant vein (emissarium condyloideum) which passes through the posterior condylar foramen and connects the lateral sinus with the deep veins of the neck. (5) A plexus of veins (rete foraminis ovalis) connects the cavernous sinus with the pterygoid and pharyngeal plexuses through the foramen ovale. (6) Two or three small veins run through the foramen lacerum medium and connect the cavernous sinus with the pterygoid and pharyngeal plexuses. (7) There is sometimes a small vein connecting the same parts and passing through the inconstant foramen of Vesalius, opposite the root of the pterygoid process of the sphenoid bone. (8) A plexus of veins (plexus venosus caroticus internus) traverses the carotid canal and connects the cavernous sinus with the internal jugular vein. (9) A small vein (emissarium occipitale) usually connects the occipital vein with the lateral sinus or the torcular Herophili and the occipital diploic vein. (10) A vein is usually transmitted through the foramen cecum and connects the superior sagittal sinus with the veins of the mucous membrane of the nose.

ETIOLOGY AND PATHOLOGY

Frontal sinusitis rarely gives rise to a cerebral abscess without extension to the frontal bone and the development of osteomyelitis.[4]

4. Mosher, H. P.: Osteomyelitis of the Frontal Bone: Notes on Three Cases, J. A. M. A. **107**:942-946 (Sept. 19) 1936. Skillern, S. R., Jr.: Recovery from Acute Osteomyelitis Following Radical Operation for the Cure of Suppurative

(Footnote continued on next page)

Woodward,[5] in considering the etiology and the pathology of osteomyelitis of the frontal bone, agreed with other writers and said that Staph. pyogenes-aureus is the organism most constantly responsible for the lesion. He said that the infection of the frontal sinus occludes the ostium and places the pus under pressure. This diminishes the blood supply, which in turn gives rise to necrosis of the mucous membrane and results in thrombosis of the perforating veins. From this point the infection spreads through the diploe; this spreading of the infection is preceded by thrombosis of the diploic veins, which serve as a medium for the extension of the active organism. As the pus and granulation tissue fill the diploe, osteal necrosis takes place, and the infection then extends by emissary veins through both tables of the skull. If the infection extends through the outer table, arteries of the haversian canals as well as those of the scalp become thrombosed and additional suppuration results. If the infection extends through the inner table, veins and arteries of the dura become thrombosed and are involved in the suppurative process. Fortunately, the dura serves as an excellent barrier to extension of the suppurative process to the brain, but if pressure is increased between the dura and the skull, the cerebral veins that communicate with those in the dura become thrombosed and they in turn serve as channels for the inoculation of the substance of the brain, with resulting development of an abscess of the brain. The control of the suppurative process involving the frontal bone depends on adequate drainage, the virulence of the organism and the ability of the patient to establish immunity. Furstenberg[6] described the frontal sinus as an expanded or eroded diploic space and said that the outer walls correspond to the external plate and the inner wall to the internal table of the cranial vault. He expressed the belief that this is the chief reason for the extension of the infection of the frontal sinus into the diploic spaces. This undoubtedly explains why some patients are more vulnerable to the extension of the infection than are others, since the diploic spaces which communicate with the frontal sinus vary in size. The development of pressure within the suppurative process likewise is responsible for the rapid extension of the infection.

Suture lines about the cranial bones and the line of late ossification between the two portions of the frontal bone limit the extent of the

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Frontal Sinusitis, Tr. Sect. Laryng., Otol. & Rhin., A. M. A., 1929, pp. 147-152; Arch. Otolaryng. **11**:485-489 (April) 1930. Williams, H. L.: Osteomyelitis of the Frontal Bone Following Incomplete Operation for Acute Frontal Sinusitis, Proc. Staff Meet., Mayo Clin. **3**:338-349 (Nov. 21) 1928.

5. Woodward, F. D.: Osteomyelitis of the Skull: Report of Cases Occurring as a Result of Frontal Sinus Infection with Staphylococcus Pyogenes-Aureus, J. A. M. A. **95**:927-929 (Sept. 27) 1930.

6. Furstenberg, A. C.: Osteomyelitis of the Skull: Osteogenetic Processes in Repair of Cranial Defects, Ann. Otol., Rhin. & Laryng. **40**:996-1012 (Dec.) 1931.

process to a great degree. However, if the scalp becomes infected, these barriers are inadequate, since the infection may travel across the suture lines and through the soft tissues and may reinfect adjacent bones by way of the emissary vessels. If but one frontal sinus is infected, the immediate extension usually is confined to the right or the left half of the frontal bone of the corresponding side.

SYMPTOMS

Infections of the accessory nasal sinuses result from an extension of acute rhinitis. Trauma and contamination from swimming or diving and allergic reactions act as predisposing factors. Occlusion of the ostium of the frontal sinus promptly gives rise to localized pain, tenderness and headache. Unless the pressure is relieved and the accumulation of secretion is drained, suppurative frontal sinusitis will develop.

TREATMENT

The treatment of acute suppurative sinusitis is medical during the acute stage. Shrinkage with tampons saturated with mild protein silver followed by suction and the application of hot packs often produces relief. It is sometimes necessary to resort to the use of codeine and other drugs. At the Mayo Clinic, we avoid surgical intervention in the acute stage because of the danger of inciting osteomyelitis. If, however, it is not possible to relieve the pain by any of these measures, we sometimes drain the frontal sinus externally at its lower inner angle. This operation, however, is purely for the establishment of drainage.

In many cases chronic sinusitis can be relieved by removal of the anterior end of the middle turbinate bone and enlargement of the nasofrontal duct. If the intranasal operation is not sufficient, we then resort to the external approach and follow the method of Lynch, which preserves the external table. If the external table has been perforated, the rules laid down by Killian are followed. Lillie [7] has called attention to the two stage operation for frontal sinusitis. The intranasal work is carried out at one stage, and if this is not sufficient to clear up the condition, the external approach is then resorted to.

Craniotomy is not considered so long as there is no evidence of extension of the infection into the frontal lobe. However, the infection occasionally develops so rapidly that there is evidence of extension into the cranium before there has been an opportunity to institute surgical drainage of suppurative sinusitis, and when this has taken place, it

7. Lillie, H. I.: Osteomyelitis of the Cranial Bones Secondary to Paranasal Sinus Operations, Ann. Otol., Rhin. & Laryng. **34**:353-360 (June) 1925. Lillie, H. I., and Anderson, C. M.: The Two-Stage Operation for Suppurative Frontal Sinusitis with External Manifestations, Arch. Otolaryng. **5**:152-161 (Feb.) 1927.

appears wiser to combine the sequestrectomy for the osteomyelitis with thorough drainage of the frontal sinus by removing the posterior table than it does to perform two separate operations. When the skull has become involved, the swelling and edema extend upward over the frontal bone from the periorbital tissues. A doughy swelling develops over the involved region. If the process is allowed to continue, fluctuation may be detected but the periosteum usually remains adherent to the frontal bone until a good quantity of pus (from 5 to 10 cc.) has developed. The roentgenographic examination is extremely valuable, since rarefaction of bone may be demonstrated before fluctuation appears. It also demonstrates the extent of the involvement of the two tables of the frontal sinus. Another important observation is that the symptoms of sepsis have not disappeared after nasal drainage of the sinus. The leukocyte count is usually increased; the fever is of the septic type, and the frontal headache is severe. Coma, meningismus, general malaise and localizing cerebral signs do not appear until the infection has extended into the brain. As soon as evidence of osteomyelitis has been demonstrated, surgical intervention should be instituted. The usual tendency is to employ small stab wounds. These are ineffective; although they allow for limited drainage, they do not permit the removal of necrotic bone.

The surgical principles include (1) adequate drainage of the frontal sinus, (2) removal of pus, necrotic bone and all white dead bone, (3) preservation of the periosteum if possible and (4) concealing the incisions of the scalp within the hair line. The last principle is accomplished by employing a coronal incision placed in the hair line. The usual surgical preparations and general anesthesia are employed. The incision should extend through the scalp to include the periosteum. The scalp covering the frontal bone is then reflected forward until the frontal sinus is uncovered, after which the accumulation of pus underneath the periosteum and the osteomyelitic process is exposed. It will be apparent that the osteomyelitic process will extend upward from the frontal sinus. The disease does not include a block of bone but has a tendency to be tortuous in its progress because it has followed diploic channels. If the lesion has been operated on early in its course, the infection will be limited, but if the pathologic process has been allowed to continue for days or weeks it will be extensive and may involve both halves of the frontal bone and possibly adjacent bones. Surrounding the necrotic bone will be a zone of avascularized white, or dead, bone. Not only is it important to remove the sequestrum, the island of necrotic bone, but it likewise is important to remove the adjacent dead bone even though it involves both tables of the skull, for if a small island of avascularized bone remains it will act as a source for continuous drainage and cause further extension of the infective process. However, it is

not necessary to remove living, or bleeding, bone. The necrotic bone is removed with the curet and rongeur. Occasionally, the use of a cranial bur is necessary in order to perforate the inner table of the skull, since it is important to remove the inner table of dead bone as well as the outer table. The extent of the operation depends on the extent of involvement of the bone. Invariably the osteomyelitic process can be followed directly to the frontal sinus, where an accumulation of pus will be found. Since the osteomyelitic process usually involves both tables of the frontal bone, intracranial exposure of the posterior wall of the frontal sinus should be obtained. This permits one to retract the dura and to open the posterior wall of the frontal sinus. A bur opening is insufficient, since it is desirable to have the dura and the brain fill the frontal sinus to prevent recurrent sinusitis. Therefore, the frontal sinus should be exenterated by the posterior approach by removing all the posterior wall of the infected frontal sinus. After complete sequestrectomy and the exenteration of the frontal sinus, the entire surgical field is washed with pure tincture of iodine. The frontal sinus is packed with gauze soaked in tincture of iodine. Additional strips of similar gauze are laid in the bony channel, and all are brought out through the line of suture. Extraperiosteal infection and infection of the scalp, if present, are drained by incisions through the periosteum from underneath the flap. Extreme care is employed to avoid injury to the periosteum covering the defect over the craniotomy, since the preservation of the periosteum stimulates the formation of new bone and the filling of the defect. The gauze drains are shortened daily and are completely removed by the third postoperative day. The generous removal of necrotic bone, the complete posterior exenteration of the frontal sinus and the free use of the tincture of iodine result in primary healing of the operative wound.

Extensive sequestrectomy as employed at the Mayo Clinic has been employed innumerable times by one of us (A. W. A.) for other osteomyelitic processes involving cranial bones. It has proved to be much more effective in cleaning up an extensive process than has drainage by a mere stab wound and the curettement of localized regions, since an incomplete operation allows the infection to continue for months. Abscess of the brain invariably develops if improper drainage is instituted or if the infection is allowed to continue.

REPORT OF CASE

In April 1929 a girl aged 9 years came to The Mayo Clinic complaining of frontal sinusitis and swelling of her forehead. Seven weeks before she came to the clinic she had a severe cold, which was characterized by rhinitis. Five weeks later she complained of pain about her eyes and wakened her father at night because of this discomfort. On the following day she had a chill, and subsequently her temperature reached 104 F. The family physician suspected an

infection of the urinary tract and found pus in the urine. Urinary antiseptics were administered; however, the pain about the eyes continued, and local nasal treatment was instituted. No more chills occurred, but the septic type of fever

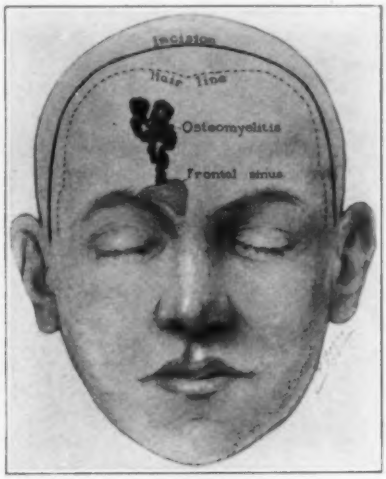

Fig. 1.—Osteomyelitis of the frontal bone extending from suppurative frontal sinusitis.

Fig. 2.—Roentgenogram revealing suppuration of the left frontal sinus and osteomyelitis involving the left half of the frontal bone (April 25, 1929).

continued. A swelling appeared above the right frontal sinus, and eight days after the onset of the symptoms a small stab wound was made and a small drain was inserted. After that the temperature subsided to normal, and the localized swelling over the frontal bone disappeared. A week later the swelling recurred;

it became more extensive and extended into the periorbital tissue and to the nose (fig. 1). There also was a recurrence of the fever. Two weeks after the onset of symptoms she was submitted to a thorough examination of the nose and throat, which did not reveal any infection of the frontal sinus. On the sixteenth and the twenty-third day, respectively, following the onset of the symptoms, small puncture-like wounds were made in the region of the frontal sinus, but no frank pus was noted.

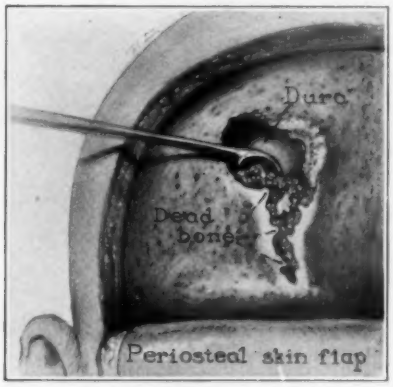

Fig. 3.—Reflection of the frontal flap and exposure of the diseased bone; illustration of the technic used for the removal of necrotic and sequestrated bone.

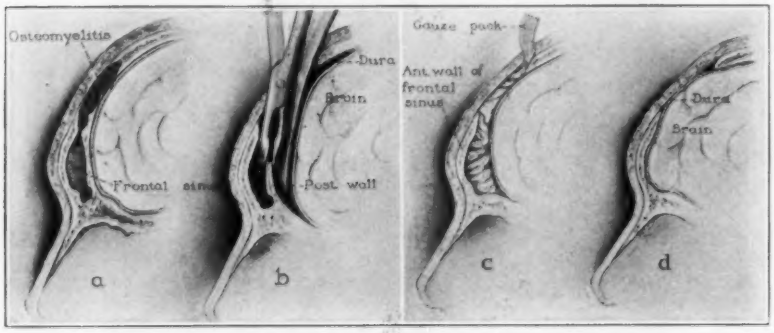

Fig. 4.—Diagrammatic sketches illustrating (*a*) the extent of the infection from the frontal sinus into the diploic spaces, (*b*) the surgical technic employed in removing the posterior wall of the frontal sinus in order to permit complete obliteration of the frontal sinus, (*c*) the appearance of the frontal sinus following the removal of the posterior table (the cavity filled with iodized gauze) and (*d*), the terminal results following the removal of sequestrated bone and the posterior plate of the frontal sinus.

Examination at the clinic revealed a swelling over the frontal lobe above the right orbit. A roentgenogram of the skull demonstrated an osteomyelitic process (fig. 2) which involved the frontal bone and extended to the frontal sinus. The sinus on the involved side appeared cloudy. The specific gravity of the urine was

1.011; the reaction was acid, and an occasional pus cell was noted. The value for hemoglobin was 60 per cent. The erythrocyte count was 4,120,000, and the leukocyte count was 10,600. The differential cell count revealed evidence of anisocytosis and poikilocytosis. The lymphocyte count was 17.5 per cent and the neutrophil count 73.5 per cent. The Wassermann reaction of the blood and the cutireaction of von Pirquet was negative. Examination of the eyes, which included refraction and a study of the ocular reflexes, pupils, muscular movements, visual fields and fundi, did not reveal any abnormality. The otolaryngologic examination

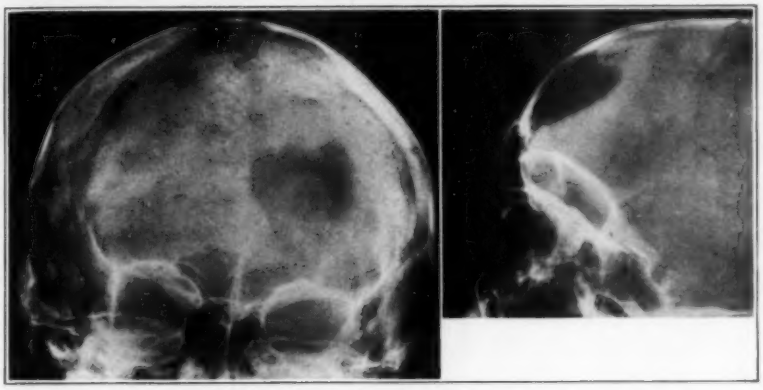

Fig. 5.—The figure on the left is a roentgenogram of the frontal bone and frontal sinus following the removal of the sequestrum and necrotic bone (May 22, 1929). The roentgenogram taken in the lateral position on May 31, 1929, illustrates the extent of the sequestrectomy and preservation of the anterior wall and the frontal sinus.

Fig. 6.—Photograph of the patient taken August 8, 1930, fourteen months after the operation.

revealed that the tonsils had been removed and that there was no evidence of acute rhinitis. The ears likewise were normal. Roentgenographic examination of the thorax and the head, except for the localized process, did not disclose anything abnormal. The neurologic examination did not reveal any evidence of an intracerebral lesion.

The patient was submitted to the operation that we have just described on April 13, 1929 (figs. 3 and 4), and was dismissed from the hospital on May 21. The wound had healed by primary intention. Postoperative roentgenograms (fig. 5) of the surgical field disclosed that the disease had been eradicated. A reexamina-

tion of the patient on July 8, 1930 (fig. 6), revealed that she had made an uneventful convalescence and had been completely free from symptoms during the interval. A small pulsating area could be detected by palpation of the right frontal region, but it was apparent that regeneration of bone was taking place and obliterating the skeletal defect.

COMMENT

The procedure employed in this case has been employed in two others with satisfactory results. Although the indications for this operative procedure may not occur often, it is a procedure which is effective in eradicating the disease without producing disfiguring scars.

A PROPOSED OPERATION FOR OSTEOMYELITIS OF THE INFERIOR ASPECT OF THE PETROUS PYRAMID

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Our experiences with two cases in which the inferior aspect of the petrous pyramid was involved encouraged us to seek a method of attacking this region surgically. We were further stimulated by the recent paper of Eagleton.[1] He mentioned three of six cases in which the condition might have been curable if the inferior aspect of the petrous pyramid had been approachable.

Recently Youngs [2] reported a most instructive case. A man 33 years of age acquired an earache in February 1933. He was first seen by Youngs in January 1934. At that time he had seven draining sinuses in his neck. Roentgenologic study revealed a dense shadow over most of the petrous area. A simple mastoidectomy was performed a few days after admission. Tracts of softened bone leading toward the petrous apex were sought but not found. Meningitis developed, and the patient died the following April. Autopsy was performed, and the temporal bone was removed and sent to us. An excavated area was observed on the inferior aspect of the bone posteromedial to the jugular bulb and behind and above the horizontal portion of the carotid canal. This cavity, which was smooth and ovoid, measured 20 by 5 mm. and took the place of the petro-occipital fissure, completely occupying the apical area up to its roof. The original course of the infection appeared to be through cells situated posterosuperiorly above the posterior semicircular canal and postero-inferiorly below this canal, extending into the apex directly below the internal auditory meatus.

At a recent meeting of the American Academy of Ophthalmology and Otolaryngology, Friesner presented a patient who was under the care of Dr. Moorhead. After mastoidectomy symptoms, disease of

1. Eagleton, Wells P.: Osteomyelitis of the Inferior Surface of the Petrous Pyramid, J. A. M. A. **107**:482 (Aug. 15) 1936.

2. Youngs, N. A.: Chronic Petrositis: Case Report and Autopsy Findings, Journal-Lancet **56**:319 (June) 1936.

the petrous pyramid developed. Pus drained from the nasopharynx for five years, during which she occasionally expectorated small bony sequestrums. She eventually recovered.

These experiences would indicate the necessity for a procedure such as we propose. While studying this problem in the morgue, one of us (R. B.) suggested an approach by way of the lateral cervical region through the retropharyngeal space.

ANATOMIC STRUCTURES INVOLVED

In the following paragraphs the anatomy of the region which constitutes the extreme roof of the retropharyngeal space is discussed. We include also a consideration of such structures as are in close

Fig. 1.—The inferior aspect of the petrous pyramid in Young's case. *1* indicates the cavity replacing the apical area after the destruction of bone; *2*, the jugular fossa; *3*, the occipital condyle; *4*, the carotid foramen; *5*, the foramen lacerum; *6*, the foramen ovale; *7*, the foramen spinosum; *8*, the spinous process of the sphenoid bone, and *9*, the stylomastoid foramen.

proximity to the avenue of approach or are closely related to the inferior surface of the petrous pyramid.

The inferior aspect of the petrous pyramid is defined as a truncated triangular area. It appears as a wedge obliquely placed between the greater wing of the sphenoid anterolaterally and the basilar portion of the occipital bone posteromedially. The base of this truncated triangle, which is directed outward and posteriorly, is recessed into an angle formed by the converging plates of the tympanic process of the temporal bone laterally and the jugular plate of the same bone medially. The apical portion, which is not a true apex, is directed inward and placed anteriorly, forming a free margin, which is the anterior margin of the quadrilateral plate of bone which covers the horizontal portion of the

internal carotid artery. This quadrilateral plate represents the area of bone involved in osteomyelitis of the inferior surface and is the region to be attacked in the proposed operation.

The inferior aspect of the wedge has an anterolateral, a posteromedial and a posterior margin within the angle formed by the converging plates of bone mentioned. In addition, there is a free anterior margin which constitutes the posterior boundary of the foramen lacerum. There are several important structures on the anterolateral margin from behind forward: (1) the extreme medial end of the petrotympanic fissure, (2) the spinous process of the greater wing of the sphenoid bone, (3) the foramen spinosum, (4) the petrosphenoid fissure and (5) the anterolateral margin of the foramen lacerum. The posteromedial margin presents from behind forward: (1) a dehiscence between the jugular plate of the occipital bone, this gap being bridged across by a part of the under-aspect of the pyramid and correlated with the location of the canal for the ductus cochlearis and (2) the petro-occipital suture which continues forward into the posteromedial margin of the foramen lacerum. The foramen lacerum lies between the anterior margin posteromedially and the posterior free margin of the median pterygoid plate.

On the inferior aspect of the pyramid three important structures are well defined. Situated from behind forward are (1) the foramen for the internal carotid artery, (2) a quadrilateral area of bone which constitutes the floor of the horizontal portion of the carotid canal and (3) the foramen lacerum, which in the nonmacerated skull is filled with fibrocartilage; this foramen lies below the internal carotid artery as it leaves the petrous bone. Here the artery enters into relationship with the cavernous sinus and other structures in the cranial cavity above the fibrocartilage which fills the foramen.

In front of the foramen lacerum is the root of the medial pterygoid plate. This structure lies out of the field of operation and is of importance because of the attachment to it of the superior constrictor pharyngis muscle and the muscles of the palate. It can be readily felt with the palpating finger.

Lateral to the anterolateral margin of the foramen lacerum is the foramen ovale, which transmits the mandibular division of the fifth nerve, the pterygoid veins and an accessory meningeal artery. Posterior and external to this foramen is the foramen spinosum, through which passes the middle meningeal artery and the nervus spinosus, the recurrent meningeal branch of the mandibular nerve. The processus spinosus is situated posteromedially to its foramen. This process is located between the foramen spinosum and the carotid foramen, with a small part of the tympanic plate interposed.

The quadrilateral area of bone between the carotid foramen and the foramen lacerum may be divided into a lateral and a medial portion. The lateral portion gives attachment to the origin of the levator veli palatini muscle, which extends backward to the region of the processus spinosus, therefore being in relation to the lateral margin of the carotid foramen. The medial part of the quadrilateral area gives attachment to some fibers of the superior constrictor muscle.

On the pharyngeal aspect of the basilar portion of the occipital bone in front of the foramen magnum is the pharyngeal tubercle for the attachment of the pharyngeal aponeurosis and the median raphe of this sheet of muscles. This lies in the sagittal plane of the posterior aspect of the pharyngeal musculomembranous funnel.

The styloid process gives rise to three muscles, the stylohyoid anteriorly, the styloglossus medially and the stylopharyngeus posteriorly. At the base of the styloid process posteromedially is the stylomastoid foramen, which transmits the facial nerve and the stylomastoid branch of the postauricular artery. Laterally and posteriorly from the position of the foramen is a well marked groove, which lodges the attachment of the posterior belly of the digastric muscle.

The superior constrictor muscle of the pharynx arises in part from the lower margin of the medial pterygoid plate and from the hamulus. This muscle sweeps posteriorly around the palatal muscles, embracing them as it meets its fellow of the opposite side in the median raphe posteriorly. The fascia pharyngobasilaris is a strong fibrous membrane which comprises the supporting substance of the upper three fourths of the pharyngeal wall. One of its several attachments superiorly is the quadrilateral plate of bone on the inferior aspect of the petrous pyramid which forms the floor of the horizontal portion of the carotid canal in front of the carotid foramen.

The palatine muscles are in close relation to the inferior aspect of the petrous bone. The levator veli palatini muscle originates from the region anterior to the carotid canal. It also originates from the lower margin of the eustachian tube and is inserted into the aponeurosis of the soft palate. Some of its terminal fibers join those of the muscle of the opposite side.

The tensor veli palatini muscle originates from the scaphoid fossa of the sphenoid bone and from the lateral aspect of the membranous and cartilaginous wall of the eustachian tube to be inserted into the transverse ridge on the lower surface of the horizontal portion of the palate bone and into the palatal aponeurosis. The cartilaginous portion of the eustachian tube, which is supported by the upper fourth of the free posterior margin of the median pterygoid plate, is medially placed between these two muscles. On the anterior aspect of the vertebral column the attachment of the prevertebral muscles can be seen. These

muscles are bound down by an extension of the prevertebral fascia. Between this and the vertebral aspect of the constrictors of the pharynx is a cleavage plane containing loose cellular tissue, the retropharyngeal space.

OPERATION

The objective of this operation is the region of the quadrilateral plate of bone which constitutes the floor of the carotid canal, situated between the carotid artery and the foramen lacerum.

Anesthesia may be local or general.

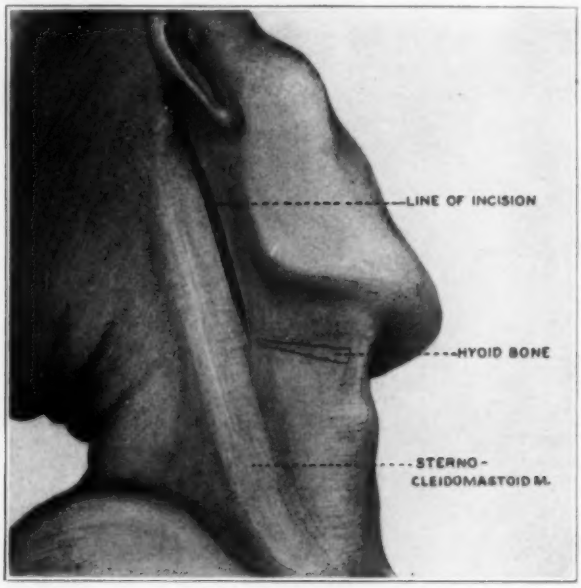

Fig. 2.—The line of incision used.

Procedure.—The patient is placed on his side in the recumbent position, with the side of the neck to be operated on extended. Incision is made along the anterior margin of the sternocleidomastoid muscle from the retromandibular or premastoid area down to the level of the hyoid bone. The incision extends down to the superficial fascia. Incision is made cautiously through this fascia in the upper part of the wound to avoid injury to the parotid gland anteriorly and to the facial nerve above. The anterior margin of the muscle is identified and is exposed by blunt dissection. At the same time the posterior belly of the digastric muscle is brought into view. From this point on blunt dissection is resorted to until the quadrilateral plate is brought into view. A curved blunt hemostat or Mayo scissors are used. After the carotid

sheath is identified it is retracted backward and outward with the sternocleidomastoid muscle. Included also in the retraction will be the posterior belly of the digastric muscle and the muscles attached to the styloid process. This posterior retraction protects the carotid sheath and keeps the facial nerve out of the field. The object is to enter the free space behind the pharyngeal muscles and in front of the prevertebral fascia, stripping up to the base of the cranium. The dissector readily falls into the retropharyngeal space and rests on one of the upper vertebral bodies. Retraction of the pharyngeal muscles is made upward and inward and will include the levator and tensor veli palatini muscles and the ascending pharyngeal artery, which may be seen coursing along the lateral wall of the pharynx.

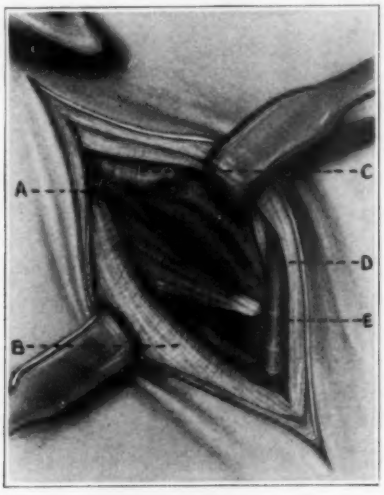

Fig. 3.—The structures exposed down to and including the superficial fascia. *A* indicates the external jugular vein; *B*, the sternocleidomastoid muscle; *C*, the parotid gland; *D*, the digastric muscle (posterior belly), and *E*, the posterior facial vein.

The position of the quadrilateral plate may be recognized by the attachment of the tendinous sheath of the levator muscle of the palate. This marks the lateral margin of the plate directly adjacent to the carotid foramen, which is identified by the pulsating artery entering it. The finger passed directly in front of and medial to the artery comes in contact with the tendinous covering of the quadrilateral plate. The levator muscle and the pharyngeal aponeurosis are attached firmly to this plate of bone, so that it is necessary to strip part of these attachments away with an elevator to expose the bone.

If the examining finger is moved forward and medially, it will meet the foramen lacerum, a space which is ordinarily filled with fibro-

cartilage. Just forward from this one again encounters a hard, resistant structure, the point of intersection of the root of the medial pterygoid plate and the lateral margin of the basilar process of the occipital bone. In the fully developed skull the quadrilateral area of bone between the carotid foramen and the foramen lacerum is roughly a little more than 1 cm. square. The area of the foramen lacerum is slightly less than that of the bone.

We have approached the apex by removing part of the quadrilateral plate covering the horizontal course of the carotid artery in the cadaver. This is done under the control of direct vision by means of a special hand bur. The bone, when not diseased, is thick and hard, and its penetration is not easy. For this reason it is of importance to keep

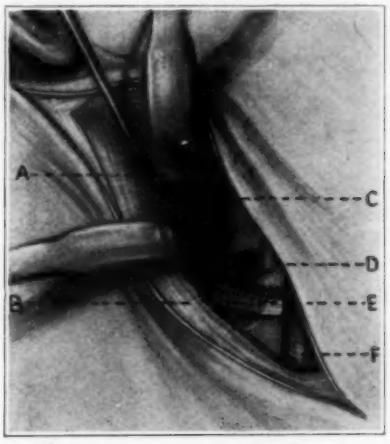

Fig. 4.—The structures exposed to reach the inferior aspect of the petrous pyramid. *A* indicates the tendon of the levator veli palatini muscle; *B*, the sternocleidomastoid muscle; *C*, the superior constrictor pharyngis muscle; *D*, the stylopharyngeus muscle; *E*, the posterior belly of the digastric muscle, and *F*, the posterior facial vein.

the penetrating instrument confined to the quadrilateral plate of bone and away from the carotid artery laterally and the foramen lacerum medially. Penetration of the foramen lacerum brings the instrument into the middle fossa and in intimate contact with the gasserian ganglion, the carotid artery, the cavernous sinus and other vital structures. The sharp bur must therefore be placed accurately into the quadrilateral plate and must be used in a posteromedial direction. The artery is readily seen after the bone is removed. In the cadaver it appears as a bluish, cordlike object. It is readily moved from its canal by means of a special angulated probe.

The procedure described is that used experimentally on cadavers. Attention is called to the fact, therefore, that in a patient suffering from osteomyelitis of the inferior aspect of the petrous pyramid the procedure would be different from that practiced on the cadaver. The operator would encounter either pus or softened bone or both in the region of the quadrilateral plate, so that adequate drainage could be secured with an appropriate instrument. In the case reported by Youngs and in that of Moorhead, pus and softened bone would have been encountered in the region of the quadrilateral plate, so that it would have been an easy matter to secure adequate drainage.

This procedure may be used as an approach to the jugular bulb when indicated.

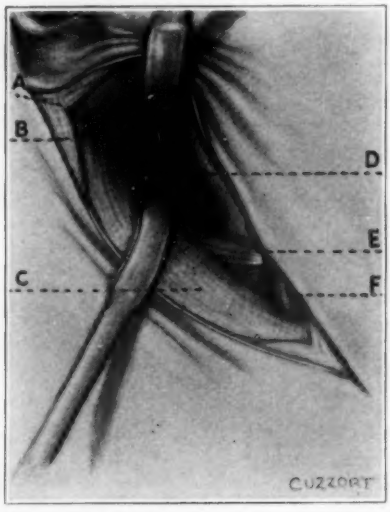

Fig. 5.—The structures exposed to reach the inferior aspect of the petrous pyramid. In addition to the exposure shown in figure 4, part of the quadrilateral plate has been removed to expose the carotid artery in its horizontal position. *A* indicates the inferior aspect of the petrous apex; *B*, the internal carotid artery; *C*, the sternocleidomastoid muscle; *D*, the superior constrictor pharyngis muscle; *E*, the posterior belly of the digastric muscle, and *F*, the posterior facial vein.

It is important to remember that when the retropharyngeal soft tissues are retracted forward, they come in contact with the base of the tongue, tending to cover the superior laryngeal aperture and to threaten the patient with asphyxia. It is therefore important to use an indirect intubation tube, such as that of Mosher or that designed by one of us (M), to insure a constantly patent airway (fig. 6). This procedure should be considered not as elective but as obligatory. It is indispensable for the safety of the patient.

Shortly after the first part of this paper was written we had an opportunity to use this operation on a living patient:

A man 44 years of age was admitted to the service of Dr. Golden, on Nov. 2, 1936. A Caldwell-Luc operation was performed on the left antrum. On November 19 bilateral otitis media developed, requiring the incision of both ear drums. On December 5 mastoidectomy on the left side was necessary. On December 29 the right ear again discharged. On January 14 he complained of severe headache in the right frontal, temporal and occipital regions. At that time the spinal fluid was under slight pressure and contained 30 cells per cubic millimeter. An extensive mastoidectomy was performed on the right side. Considerable destruction of bone was noted. His postoperative condition was satisfactory, but the pain in the temporal region persisted. On February 4 Horner's syndrome on the right side was recognized. The pupil was smaller, the palpebral fissure was definitely narrowed, and the eye appeared smaller. A lesion in the carotid canal implicating the pericarotid sympathetic nerves was suspected. The patient was closely watched until a roentgenogram in the base position revealed definite evidence of destruction in the inferior region of the petrous apex.

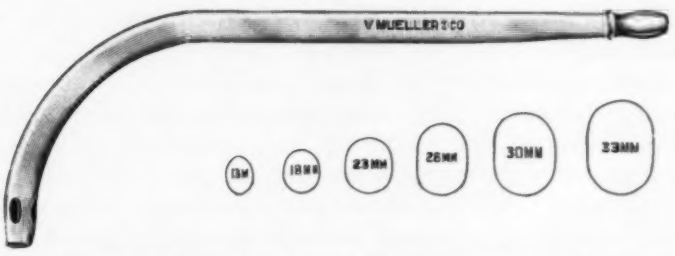

Fig. 6.—The indirect intubation tube used for maintaining the airway during operation.

On March 6 the operation described was carried out with the patient under anesthesia induced with tribromethanol supplemented by nitrous oxide and ether. When retraction of the prevertebral structures was made anteriorly, it was noted that the patient had a tendency to stop breathing. An indirect intubation tube was placed through the glottis so that the patency of the airway was maintained. During the operation only anterior, inward and upward retraction were found necessary. The posterior structures did not interfere with the procedure. The quadrilateral plate of bone was exposed by gently scraping the attachment from it of some of the fibers of the levator palatini muscle and the pharyngeal aponeurosis. This bone was found greatly softened. When attacked with a special ball-tipped probe, it yielded, so that an opening was made through it. From this opening there gushed approximately 3 drachms (11 cc.) of pus, which filled the depths of the wound. This was aspirated, and a rubber dam drain was inserted. At the time of writing, one week after operation, the patient is comfortable.

We would emphasize that this operation should not be attempted unless the surgeon has done some preliminary work on cadavers. It is suggested that the inferior aspect of the skull be studied carefully just prior to the performance of this operation.

PULMONARY COLLAPSE FOLLOWING TONSILLECTOMY UNDER LOCAL ANESTHESIA

REPORT OF A CASE

SAMUEL IGLAUER, M.D.
CINCINNATI

In recent years a great deal of attention has been paid to the subject of pulmonary collapse, or atelectasis. Atelectasis may occur as a secondary manifestation of some bronchopulmonary condition or as a postoperative complication. In the opinion of that eminent physician Frederick Lord:[1] "The clinical recognition of atelectasis as a common and important complication of various bronchopulmonary conditions is the most important single advance in physical diagnosis since the time of Laennec."

Although the clinical and roentgen diagnosis of frank atelectasis is comparatively simple, there is still some controversy as to the etiology and pathogenesis of this condition. This paper will be limited to a consideration of postoperative pulmonary collapse.

It has been found that atelectasis occurs most frequently after abdominal operations, especially those on the upper part of the abdomen. In the series of laparotomies studied by Muller, Overholt and Pendergrass,[2] postoperative measurements showed a marked reduction in the vital capacity, and a comparison of roentgenograms made before and after operation showed in all cases a definite diminution in the volume of the chest, with narrowing of the intercostal spaces and elevation of the domes of the diaphragm. In addition, air was frequently visible pocketed beneath the diaphragm. These authors concluded that bronchial obstruction, per se, is not the primary factor in the production of atelectasis after operations on the upper part of the abdomen, but that the elevated diaphragm exerts active compression on the lower lobes of the lungs. The bronchi and bronchioles become

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From the Department of Otolaryngology, College of Medicine, University of Cincinnati.

Read at the meeting of the American Laryngological, Rhinological and Otological Society, Denver, May 18, 1936.

1. Lord, F. T.: Collapse, Pulmonary, in Piersol, G. M.; Bortz, E. L., and others: Cyclopedia of Medicine, Philadelphia, F. A. Davis Company, 1933, vol. 8, pp. 364-378.

2. Muller, G. P.; Overholt, R. H., and Pendergrass, E. P.: Postoperative Pulmonary Hypoventilation, Arch. Surg. **19**:1322 (Dec., pt. 2) 1929.

obstructed because their lumens become narrowed, and because of diminished pumping action the current of air passing through them becomes stationary.

The reduced vital capacity and the high stand of the diaphragm after laparotomy are probably due to several factors, including splinting of muscles from pain meteorism, tight bandages and air under the diaphragm. All these diminish expulsive cough and thus favor the retention of bronchial secretions, which, in turn, may lead to plugging of a bronchus with absorption of air and collapse of the portion of the lung distal to the obstruction.

The irritation of the bronchial mucosa from ether anesthesia may play a rôle by exciting bronchial secretion and edema, but, curiously enough, in the experience of Brunn [3] and of Middleton,[4] atelectasis is as common after spinal anesthesia as after inhalation anesthesia.

Another factor not hitherto considered is the aspiration of saliva, often in considerable amounts, which, according to the bronchoscopic studies made by Lowenthal [5] at the Cincinnati General Hospital, occurs in about 72 per cent of etherized patients.

It is apparent that the reduced vital capacity and impaired cough, with retained bronchial or salivary secretions, serve to explain many cases of pulmonary collapse after laparotomy. On the other hand, it is much more difficult to account for the occurrence of atelectasis after operations on or injuries to more remote parts of the body. Some of the cases cited by Bradford [6] come in this category. In his war experience he occasionally observed atelectasis after trivial, nonpenetrating wounds of the chest wall. Strangely enough, the collapse often occurred on the side opposite to that injured. He also observed massive collapse as a result of other injuries, especially wounds of the buttocks, pelvis and thighs. In the cases of atelectasis arising after contralateral injury to the chest Bradford was inclined to exclude obstruction of the main bronchi as a common or probable cause. With the other injuries the constrained and unnatural posture assumed by the patients may have been a factor in the production of the pulmonary complication. Curl,[7]

3. Brunn, H.: Collapse, Pulmonary, Postoperative, in Piersol, G. M.; Bortz, E. L., and others: Cyclopedia of Medicine, Philadelphia, F. A. Davis Company, 1933, vol. 8, pp. 379-388.

4. Middleton, W. S.: Lecture and personal communication.

5. Lowenthal, G.: Tracheobronchial Aspiration of Buccopharyngeal Secretion During Ether Anesthesia (Immediate Postoperative Bronchoscopic Study of Twenty-One Patients), Arch. Otolaryng. **21**:561 (May) 1935.

6. Bradford, J. R.: Massive Collapse of the Lung as a Result of Gunshot Wounds, with Especial Reference to Wounds of the Chest, Quart. J. Med. **12**: 127, 1918-1919.

7. Curl, S. W.: A Contribution to the Study of Contralateral Signs in Gunshot Wounds and Injuries of the Chest, Quart. J. Med. **12**:161, 1918-1919.

who also made a study of gunshot wounds of the thorax, suggested that injury to the lung and pleura on the unwounded side may result from contrecoup in a manner similar to that which occasionally occurs to the brain and meninges after injury to the head.

A case of pulmonary collapse after hemorrhoidectomy has been reported (Scrimger [8]). Cases have also been reported in which collapse occurred after a fall from a horse or a bicycle, with a bruise of the trunk without fracture of bones.[1]

According to Henderson's [9] theory, any severe operation causes shock characterized by failure of the venopressor system, with retarded venous flow and subnormal carbon dioxide content of the blood. Failure of the respiratory system ensues, with diminished excursions of the chest and diaphragm, which, in turn, favor the occurrence of pulmonary collapse. As a prophylactic and therapeutic measure, Henderson therefore recommended the inhalation of carbon dioxide after operation to stimulate the breathing center and to restore the tone of the thoracic and other muscles.

According to the experimental studies of Coryllos and Birnbaum,[10] pulmonary collapse cannot occur in the absence of bronchial obstruction of some sort or other. That bronchial plugging is an important causal factor in many cases of atelectasis has been proved by the excellent therapeutic effects of bronchoscopic aspiration, as reported by Lee, Tucker and Clerf,[11] Brunn,[3] Jackson and Lee,[12] Tucker [13] and others.

Wilmer [14] and his associates have called attention to the surprising incidence of allergy and asthma found in a small group (ten) of patients who had postoperative atelectasis. These observations naturally bring up the question of bronchospasm and edema, which a few authors regard as a factor in the pathogenesis of atelectasis. At a recent meeting of

8. Scrimger, F.: Postoperative Massive Collapse of the Lung, Surg., Gynec. & Obst. **31**:486 (June) 1921.

9. Henderson, Y.: Postoperative Atelectasis as a Feature of Shock, in Piersol, G. M.; Bortz, E. L., and others: Cyclopedia of Medicine, Philadelphia, F. A. Davis Company, 1933, vol. 11, p. 231; Carbon Dioxide, ibid., vol. 3, p. 115.

10. Coryllos, P., and Birnbaum, C. G.: Syndrome of Pneumococcic Bronchial Obstruction: Experimental Production of Atelectasis or Lobar Pneumonia with Human Pneumonic Sputum: Suggestions for Prevention and Therapeutic Treatment, Arch. Int. Med. **51**:290 (Feb.) 1933. Coryllos, P., in discussion on Muller, Overholt and Pendergrass.[2]

11. Lee, W.; Tucker, T., and Clerf, C.: Postoperative Pulmonary Atelectasis, Ann. Surg. **88**:6, 1928.

12. Jackson, C., and Lee, W.: Acute Massive Collapse of the Lungs, Ann. Surg. **82**:364, 1925.

13. Tucker, G.: Bronchoscopic Observations on Obstructive Pulmonary Atelectasis, Arch. Otolaryng. **13**:315 (March) 1931.

14. Wilmer, C.: The Incidence of Allergy and Asthma in Postoperative Collapse, Ann. Surg. **91**:651 (May) 1930.

the American Medical Association (1936), Waldbott presented sections from lungs showing alveolar edema, compression and emphysema, which he attributed to the allergic effect of the injection of procaine hydrochloride.

In consideration of the various factors which might bring about atelectasis, one would scarcely expect this complication to occur after such an operation as tonsillectomy performed with local anesthesia. Nevertheless, such a complication occurred in a patient in my service at the Cincinnati General Hospital. The signs and symptoms in this

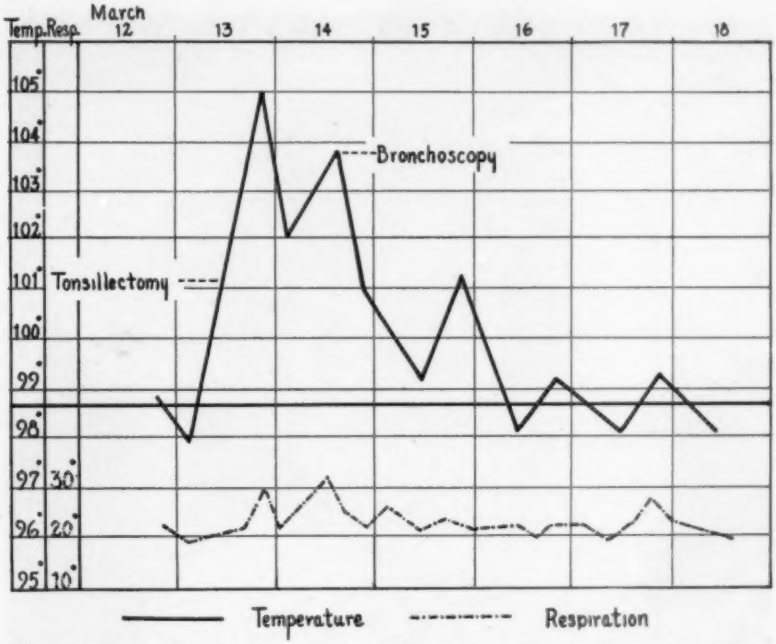

Fig. 1.—The clinical effect of bronchoscopic aspiration in posttonsillectomy pulmonary collapse.

case were so characteristic as to leave no doubt as to the correctness of the diagnosis. So far as I am aware, no similar case has been reported in the literature, although Goodyear [15] and Middleton [4] each informed me that he encountered this complication on one occasion.

REPORT OF CASE

F. D., a white youth aged 18, was admitted to the Cincinnati General Hospital on March 12, 1935, for tonsillectomy. On admission the pulse, respiration and temperature were normal. The chest was clear to percussion and auscultation, and the heart was normal in size, position and function. The tonsils were hypertrophied.

15. Goodyear, H.: Personal communication to the author.

On the following morning, after a preliminary dose of morphine sulfate 1/6 grain (0.01 Gm.) and atropine sulfate 1/150 grain (0.43 mg.), tonsillectomy was performed with infiltration anesthesia (1 per cent procaine hydrochloride with 8 drops of epinephrine hydrochloride to the ounce). There was less than normal bleeding during the operation.

On his return to the ward the patient slept most of the time. There were no complaints except of some soreness in the throat. There was no excessive bleeding until about 6 p. m., when he expectorated a considerable amount of bright red blood. Codeine and acetylsalicylic acid were given twice for severe sore throat. At 11:30 p. m. he expectorated a large amount of thick, purulent material and bright blood. During the course of the day the temperature rose

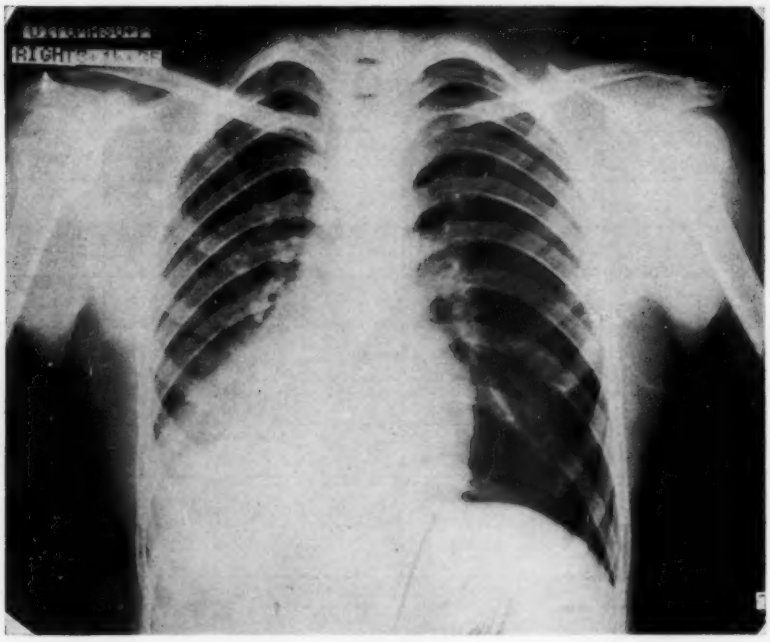

Fig. 2.—Roentgenogram taken on March 14, 1935. The lower costal interspaces on the right side are narrowed. The right side of the diaphragm is markedly elevated. The silhouette of the heart is shifted to the right. The right border of the heart is distinctly visible beyond the right margin of the sternum. There is an area of infiltration in the lower lobe of the right lung. The left side of the chest is relatively clear.

rapidly to a maximum of 104.8 F., with a corresponding increase in the pulse rate (to 120) and the respiratory rate (to 30), as seen in figure 1.

By the following morning (March 14) the temperature had fallen to 102 F. The patient complained of general discomfort and pain in the chest. Physical examination revealed limited respiratory excursions in the region of the lower lobe of the right lung, with decreased tactile fremitus and an impaired percussion note. The breath sounds, voice sounds and whispered voice were also diminished over the lower lobe of the right lung. There were many coarse râles and

wheezes over the middle of the right side of the chest posteriorly. The heart was definitely shifted to the right. The patient expectorated a moderate amount (2 ounces [59 cc.]) of thick, greenish yellow purulent material. The white cell count was 18,000, with 86 per cent polymorphonuclears. Postural drainage was instituted by placing the patient on the left side. A roentgenogram (fig. 2) taken at that time showed that the lower costal interspaces on the right side were narrowed. The right side of the diaphragm was markedly elevated. The silhouette of the heart was shifted to the right. The right border of the heart was distinctly visible beyond the right margin of the sternum. There was an area of infiltration in the lower lobe of the right lung. The left side of the chest was relatively clear.

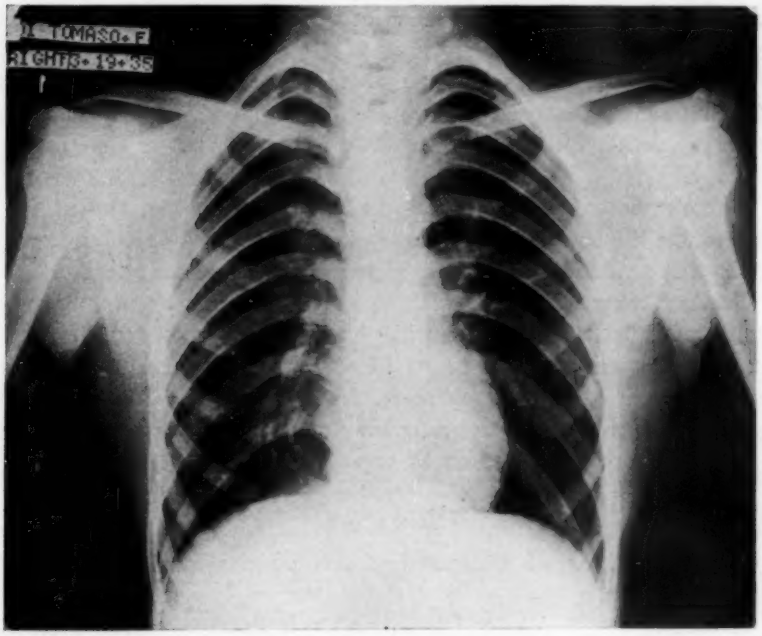

Fig. 3.—Roentgenogram taken on March 19, 1935. The interspaces are of normal width on both sides. The right side of the diaphragm is in normal position. A slight infiltration is still present in the lower lobe of the right lung. The silhouette of the heart is in normal position.

Bronchoscopy.—On the same afternoon, bronchoscopy was performed, local anesthesia being used. The right main bronchus and the bronchus of the lower lobe with its posterior branches contained about 3 cc. of mucopurulent material, which was removed by suction. The mucous membrane in this region was slightly congested. No blood clots were present. Nothing remarkable was noted in the left main bronchus.

After bronchoscopy the patient continued to expectorate blood-stained mucopurulent material; the total amount for several days was about 4 ounces (120 cc.). Postural drainage was continued. Daily roentgen and physical examination revealed rapid clearing of the chest and improvement clinically. The fever declined

rapidly. The final roentgenogram, taken after five days, showed the lungs almost clear and the heart and diaphragm in normal position (fig. 3). The patient was discharged on March 23, 1935, in good condition. About one year later, when questioned, he reported nothing indicative of allergy and showed negative cutaneous reactions to the common pollen extracts.

COMMENT

The various factors which may have favored the occurrence of atelectasis in the case just cited should now be considered. It will be noted that the operation proceeded in a normal manner. Morphine and atropine were administered prior to operation, and codeine and acetylsalicylic acid some hours later for a severe sore throat. The patient slept most of the time on returning to the ward.

The drugs, together with the painful throat, may have inhibited the cough reflex and favored the inspiration of blood (or saliva), but it should be recalled that no blood was found in the bronchi at bronchoscopy.

The element of shock appears to have been lacking, and as far as I am aware the patient was not allergic. From the discussion, it would appear that no definite cause for atelectasis can be determined.

Further investigation may show that atelectasis occurs more frequently after tonsillectomy than has hitherto been recorded. The question naturally arises as to the possible relation between atelectasis and posttonsillectomy pulmonary abscess. In this connection it is well known that an unrelieved atelectatic lung may undergo consolidation, and this pneumonic process may go on to suppuration.

SUMMARY

A brief review of the pathogenesis of postoperative pulmonary collapse is given.

A case is reported in which pulmonary collapse occurred after tonsillectomy performed with local anesthesia.

The question is raised as to the possible relation between atelectasis and posttonsillectomy pulmonary abscess.

LARYNGOPTOSIS

PTOSIS OF THE LARYNX DUE TO DOWNWARD DISPLACEMENT OF THE HYOID BONE RESULTING FROM FIBROSIS AND SHORTENING (CONGENITAL ANOMALY) OF THE LEFT STERNO-HYOID AND STERNOTHYROID MUSCLES

GABRIEL TUCKER, M.D.
PHILADELPHIA

The term laryngoptosis was first applied to the abnormally low larynx by Chevalier Jackson in 1914. In 1929 he reported that he had observed sixty-seven cases. The condition is diagnosed by palpation of the front of the neck, the location of the larynx thus being determined with reference to the suprasternal notch. Chevalier Jackson called attention to the condition and its attendant difficulties, particularly in relation to tracheotomy; the cricoid cartilage is much more likely to be cut when the larynx is at the level of the suprasternal notch.

I have been able to find no case reported in which ptosis of the larynx was due to downward displacement of the hyoid bone or, in other words, secondary to ptosis of the hyoid bone; and for this reason I thought this case worthy of report.

REPORT OF A CASE

A girl aged 12 years was referred by Dr. George M. Coates to the Bronchoscopic Clinic at the Graduate Hospital of the University of Pennsylvania for direct examination of the larynx and the trachea, because of abnormality in the position of the larynx in the neck and the possible relation of this malposition to the difficulty in speaking which the patient manifested.

Previous History.—The mother stated that the child had always been in good health but had never been able to speak clearly. Tonsillectomy had been done four years before admission to the hospital, and the mother was told that the child was "tongue-tied." Operative measures for relief of the "tongue-tie" were carried out, and it was through these that the speech improved. Considerable difficulty was still evident; she was placed in a special class in school, and the school nurse referred her to the clinic for examination and treatment.

The report on the psychologic examination from the William McIntyre Public School was as follows: "The child was almost 9 years of age when she entered school. She had never had any personal attention and did not know how to care for herself. She had a serious speech defect. Her scores on the mental tests were far better than one would expect. She was cooperative and had a pleasing manner. She succeeded in passing an intellectual test at the 8 year level. Her intelligence quotient was 85.3. Her mental age was 8 years and 3 months."

Physical examination showed the child to be well developed and well nourished; examination of the nose and throat gave negative results. Examination of the larynx with a mirror showed normal motility of the arytenoid cartilages and the vocal cords, but the larynx was pulled downward and appeared to be so deeply situated in the hypopharynx that an impression of the epiglottis being pushed backward over the arytenoid cartilages was produced. The glottis seemed normal, and the tone produced on an attempted phonation was clear, although she had great difficulty in articulation and in protruding the tongue beyond the lower teeth.

Examination of the neck showed that the child held her head in an abnormally forward position. When the head moved backward, the lower jaw was pulled downward, so that the mouth would open. She could close her jaws only when the head was well forward. The front line of the neck extended in a straight line from the symphysis of the mandible to the suprasternal notch. On palpation

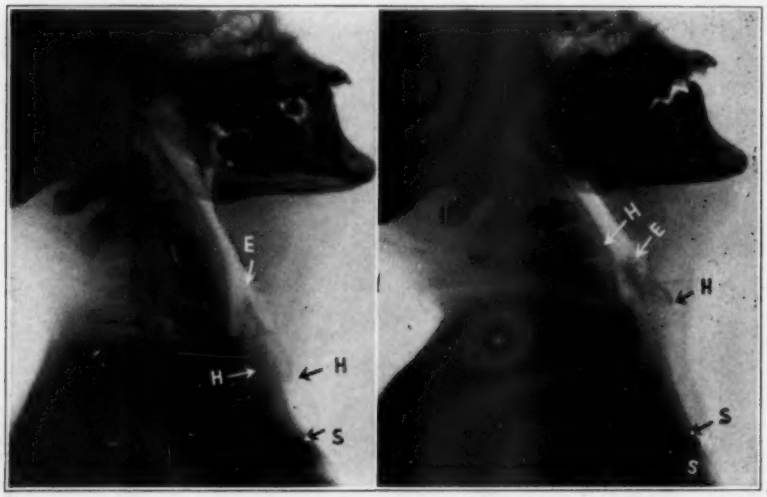

Fig. 1.—Left, a lateral roentgenogram showing the relation of the epiglottis (*E*), the hyoid bone (*H*) and the suprasternal notch (*S*) before operation. Right, a lateral roentgenogram of the neck after operative removal of the fibrous band. The hyoid bone (*H*) has ascended to practically its normal position. The normal relation between the hyoid bone (*H*) and the epiglottis (*E*) has been restored. The body of the hyoid bone has ascended to the normal position, which is three times the distance from the sternoclavicular joint that existed before operation.

no adenopathy was noted, but the tissues in the front of the neck were dense. The hyoid bone could be felt distinctly just above the suprasternal notch. The larynx was apparently just below and in close contact with the hyoid bone at the level of the suprasternal notch, the cricoid cartilage being well below the upper border of the sternum. There was a firm fibrous band about the diameter of a lead pencil extending from the posterior surface of the left sternoclavicular joint to the hyoid bone. The right side of the neck seemed soft, and no constricting band could be felt. When swallowing was attempted, the larynx did not rise in the neck in the normal manner. There was no palpable adenopathy.

Roentgen examination showed no abnormality of the chest. The anteroposterior view of the neck revealed no abnormality, but the lateral film of the soft tissues of the neck showed the hyoid bone to be just above the suprasternal notch, with a disturbed relationship between the hyoid bone and the tip of the epiglottis (fig. 1).

Bronchoscopic examination was made to determine whether there was any abnormality in the trachea and the bronchi. It was thought from this examination that the left main bronchus came off more nearly at a right angle than normal and the bronchi of the lower lobe seemed shortened as though there was downward displacement of the bifurcation of the trachea. No angulation of the trachea

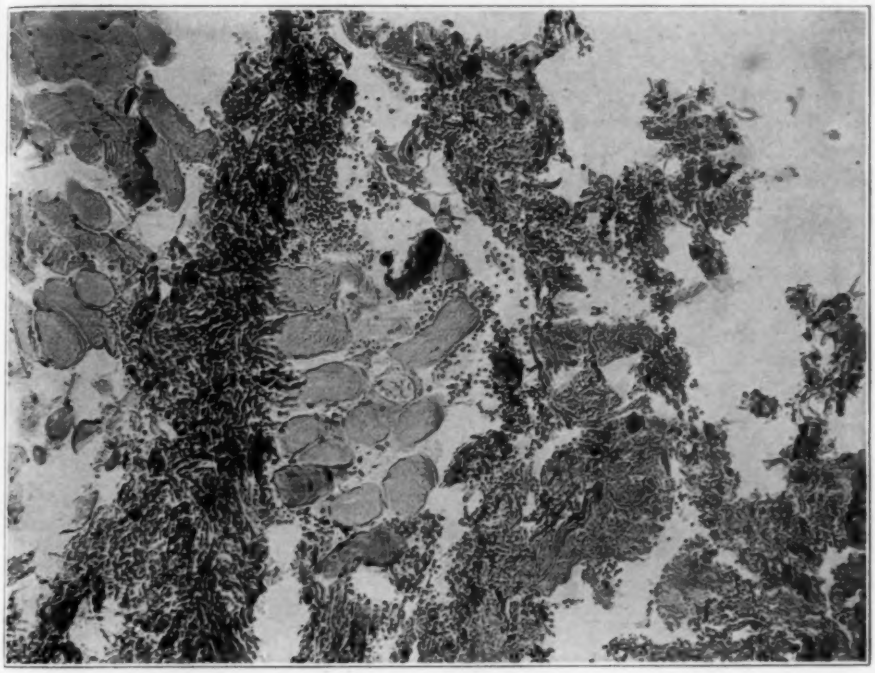

Fig. 2.—Photomicrograph of tissue from the fibrous band. "The specimen consists of muscle and fibrous tissue" (Dr. E. A. Case).

was apparent on bronchoscopic examination. Bismuth subcarbonate was insufflated into the trachea and the main bronchi, and examination of films made after this insufflation confirmed the bronchoscopic findings.

The inference from diagnostic examination was as follows: "Contracture of the left sternohyoid and sternothyroid muscles with fibrosis of the muscles and shortening to such an extent that the hyoid bone was pulled downward." In consultation with Dr. George M. Coates it was thought advisable to resect the constricting band of tissue that occupied the usual position of the left sternohyoid and and sternothyroid muscles to determine whether this would not correct the downward displacement of the hyoid bone and the larynx by allowing them to ascend to the normal position.

Operation—With the area under local anesthesia a vertical incision was made parallel with the long axis of the constricting band directly over it, and the constricting tissue was exposed. The appearance was that of a tendinous mass, which apparently replaced the sternohyoid and the sternothyroid muscle. The band was dissected free from the surrounding tissues, and a small portion was excised. There was no bleeding, and when the tendinous band was cut through the hyoid bone immediately ascended in the neck nearly to the normal position, the larynx going up with it. The wound healed without complication. The histologic examination of the tissue from the fibrous band was reported by Dr. E. A. Case as follows: "The specimen consists of muscle and fibrous tissue. The fibrous tissue is dense and preponderates over the muscle tissue, which is localized. The impression given is that the fibrous tissue is attached to the muscle much like a tendon" (fig. 2).

Result.—After the removal of the fibrous band, the larynx resumed practically its normal position (fig. 1 *B*), and on examination with a mirror it was seen to be more nearly at the normal level. The child could readily protrude her tongue beyond her teeth; she could throw her head backward without the mouth opening, and she was able to articulate much more clearly than before the larynx assumed the normal position.

COMMENT

An unusual case is reported of laryngoptosis due to replacement of the left sternohyoid and sternothyroid muscles by a tendinous band pulling the hyoid bone and the larynx downward.

The condition was probably congenital, although this could not be determined accurately. No history of birth injury was obtained.

The result of the resection of the fibrous band has been satisfactory in overcoming the downward displacement of the larynx and the hyoid bone. The child's speech defect was due in part to interference with the proper use of the tongue by the downward displacement of the hyoid bone. Correction of the abnormality has improved the speech.

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TREATMENT OF ASTHMATIC PATIENTS IN OTOLARYNGOLOGIC PRACTICE

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Out of the maze of conflicting opinions regarding asthma, it is agreed that it is a syndrome of which the cause is unknown but which is alleviated and sometimes cured by various procedures, such as the administration of specific or nonspecific proteins as well as the removal of infected foci.

It is further agreed that rather than indiscriminately operate on these persons one should first undertake a most elaborate allergic and laboratory survey. Only after failure of the allergist should operative procedures be considered. Further, it must be conceded that the allergic person is entitled to a cure of his sinus difficulties as is the nonallergic person and that when he presents himself to the rhinologist with chronic sinusitis the condition must be palliated. Should radical procedures be required, his allergic condition certainly would not be a contraindication to those manipulations.

On the other hand, failure in surgical treatment is frequently due to overzealous surgical intervention in patients for whom the procedures are not warranted, i. e., whose pathologic condition in a nonallergic person would call for less radical and possibly nonsurgical methods. This results in the same discomfort to the patient as is seen in nonallergic persons, except that the allergic patient who already suffers from a neurosis naturally feels a great deal worse, since a severe sinus infection is added to one of only moderate previous severity. One might add the axiom: Do for the allergic patient only that which would be indicated were he nonallergic.

Briefly, the surgical treatment of disease of the sinuses in the allergic patient is no different from that practiced for the nonallergic person, except that the allergic patient may be a poorer surgical risk and hence must be prepared for operation more carefully than the nonallergic patient. Certainly an allergic patient with complete destruction of the nasal and sinus mucosa by polyposis will not be cured of this difficulty

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by being desensitized to offending allergens. Only by thoroughly removing the large masses of pathologic tissue and allowing new tissue to regenerate will the patient be enabled to receive any benefit from his medical treatment, i. e., desensitization. It seems reasonable to believe that a patient, allergic or nonallergic, with a deep-seated purulent infection or a gross obstructive lesion, if cured of these conditions, must show some improvement in his general health. Regenerated nasal and sinus mucosa is apparently anatomically normal and, it would seem, also physiologically normal.

The work reported herein covers seven years at the University of Illinois Medical School and twelve years of private practice, in which time various surgical and nonsurgical procedures have been tried on asthmatic patients. The cases reported include only those of at least five years' duration. This work has afforded us an opportunity to compare results from surgical procedures of both conservative and nonconservative type with results obtained by nonsurgical methods. One hundred and fifty private and clinic patients are included in the surgical survey and a like number in the nonsurgical survey.

PROCEDURE OF SURVEY

The routine survey of asthmatic patients was carried out as follows: The patient was first admitted to the department of allergy, where a careful history and a complete physical examination were made. Laboratory tests included complete examination of blood, urine and sputum, cutaneous tests and roentgen study of the chest together with any special procedures which might be indicated, such as determination of basal metabolism and electrocardiographic study. With this information, the patient was referred to the department of otolaryngology, where a careful inspection of the nose, throat and chest was made. This included a roentgenogram with iodized poppy-seed oil (when indicated), biopsy and examination of both cultures and smears of exudates recovered from the nose, throat and bronchi. When necessary, bronchoscopic examination was made, though frequently studies of the chest after the injection of iodized poppy-seed oil yielded more information.

After this examination, the patients with frank pathologic processes, such as suppuration or polyposis, were treated immediately in the department of otolaryngology, such surgical procedures being carried out as we found necessary to alleviate the condition in the nose, throat and chest. If the reaction of the patient was previously negative to all allergens except bacteria, he was kept in the department of otolaryngology and treated periodically with nonspecific proteins. If, however, the patient was sensitive to allergens other than those of bacterial type, he was sent back to the department of allergy for desensitization.

The group of patients showing only bordering pathologic changes were not operated on. These, from the beginning, were treated in the department of otolaryngology or the department of allergy by nonspecific protein therapy.

As will be noted, our efforts were principally directed toward relief of the bacterial or infectious type of asthma. We hold no brief for any particular type of treatment, feeling that the rhinologist, at best,

can merely aid these persons by exercising his good judgment in clearing up infection, which occurs so readily in asthmatic persons, whether it is primarily the cause of the asthma or secondarily a contributing factor.

Though a voluminous literature has accumulated along related lines, we believe that procedures such as we have followed may be of interest to others as well as to ourselves; hence, the publication of our methods. Of particular note are the comparative data we have accumulated concerning persons undergoing partial or total operation for infectious asthma as well as those who underwent no operation. Too frequently, statistics concerning cure or failure in operative work on asthmatic persons have been based on minor procedures, such as tonsillectomy, turbinectomy, septal resection, cautery and ionization, and judged from these selected cases. The greater number of surgical failures have been reported by the internists, who themselves are unable to judge the amount or type of surgical treatment done, merely being satisfied that some surgical procedure was carried out and that the patient failed to improve. Also to blame is the otolaryngologist, who clings to the age old hypothesis that removal of spurs, septums, etc., in the so-called "trigger area" of the nose will cure asthma and who therefore sets about mutilating normal noses and starting up a vasomotor disturbance far greater than that previously possessed by the patient.

SELECTION OF PATIENTS FOR SURGICAL TREATMENT

The rule followed in our clinic is never to operate in cases of borderline conditions, i. e., those without permanent obstructive pathologic changes unless all other means of treatment have failed. The patients presenting frank, permanently obstructive changes are operated on, irrespective of their allergic status, just as one would operate on a nonallergic patient. During the period of after-care, they are sent through the usual regimen of allergic and physical examination, augmenting their treatment in our hands by that of the department of allergy. We mention permanent obstruction, indicating polyposis or suppuration, as opposed to the desultory and temporary edema noted in most of these cases during a protracted period of asthmatic attacks or hypersensitization.

In all persons selected for surgical intervention only radical exenteration of the infected sinuses was done. In cases of hyperplastic obstruction this has included all the sinuses, while in cases of suppurative obstruction only the offending sinus has been exenterated. The method of approach when the frontal and ethmoid sinuses are involved has been through an external incision known variously as the Jansen, Sewell or Smith operation. When no pathologic involvement of the frontal sinuses could be demonstrated, an intranasal radical ethmoidectomy was done. The approach to the antrums has been through the Caldwell-Luc technic.

SELECTION OF PATIENTS FOR NONSURGICAL PROCEDURES

The patients selected for nonsurgical treatment included those whose condition was of the borderline type, namely, those without enough permanent obstructive symptoms to warrant surgical treatment but who reacted negatively to all allergens.

The asthma was apparently of the infectious type, as is evidenced by its occurrence only during the "cold" months and always associated with an acute infection of the upper respiratory tract.

PATHOLOGIC, BACTERIOLOGIC AND CHEMICAL OBSERVATIONS

The gross and histologic changes of allergic tissue have been frequently and excellently described in the literature,[1] so that a discussion herein would be mere repetition. Briefly, the changes are those ordinarily described in otorhinolaryngologic literature as hyperplastic or suppurative disease. The general pathologist, however, views all these conditions as various phases of chronic inflammation, the end-result being dependent merely on the amount and severity of the irritating factor. He believes that hypertrophy or suppuration under certain conditions of heredity and stimulation ultimately causes fibrosis and that with strangulation of the blood supply, some atrophy is likely to ensue. One frequently sees in the same tissues taken from an asthmatic sinus, areas of atrophy, of hypertrophy and of suppuration. There seem to be no hard, rigid lines of demarcation and certainly no evidence that in all cases chronic sinusitis can be classified purely as hyperplastic, atrophic or suppurative per se.

Another salient controversial finding which might be mentioned is the presence or absence of bacteria in the tissues and the part they play as a causal factor of asthma. As previously reported numerous times in the literature, washings from the sinuses of asthmatic persons are likely to be sterile. We have proved by the following procedure that this is due to faulty technic or improper mediums.

Small pieces of tissue collected from twenty-five patients, which had returned sterile washings, were obtained aseptically at operation. One portion was fixed and stained by Giemsa's method while another portion was implanted in the peritoneal cavity of a guinea-pig under aseptic conditions. After forty-eight hours the implanted tissue was removed, fixed, sectioned and stained by Giemsa's method. Of the twenty-five specimens of tissue implanted, all revealed mixed bacterial growth, the coccal organisms usually predominating. Of the twenty-five specimens of tissue prepared but not implanted, we were able in only eight cases to demonstrate organisms. The organisms identified were streptococci, staphylococci, Friedländer bacilli and diphtheroids. No organisms of the gastro-intestinal flora were ever encountered which might tend to prove that contamination had not occurred from the bowels.

In an effort to ascertain to some degree the pathologic chemical changes of asthmatic tissues, material was removed at operation and frozen in liquid air.

1. Hansel, French K.: Clinical and Histopathological Studies of the Nose and Sinuses in Allergy, J. Allergy **1**:43, 1929. Mullin, W. V., and Bal, R. P.: Studies of Pathologic Tissue Removed from Chronically Infected Nasal Accessory Sinuses, Ann. Otol., Rhin. & Laryng. **37**:192, 1928. Eggston, A. A.: The Pathology of Chronic Sinusitis, Arch. Otolaryng. **12**:561 (Nov.) 1930.

This was placed in an air chamber at about —25 C. and transferred to the laboratory of Dr. Isidore Gersh, at the University of Chicago, who dried the tissues by the Altmann procedure.

"This technic," to quote Dr. Gersh, "is an ingenious method of histologic fixation of tissue without shrinkage—for the accurate localization of substances normal to the organism or introduced into the body." The advantage of this technic is that it is nonchemical and rapid, so that the usual shrinkage which takes place with ordinary fixation methods is absent. From the standpoint of chemical analysis of the tissues the latter point is important, since change in the composition of tissue, salts and lipoids takes place because of the diffusion of alcohol and formaldehyde through the tissue. The exact technic would be irrelevant to this short paper, but a statement of Dr. Gersh's conclusions follows:

The subsequent treatments and observations are described for each individual section.

Section 1 was treated with purified petroleum benzine and balsam and was unstained. The spaces in the connective tissue framework were filled with a homogeneous substance showing no signs of a finer network. The eosinophilic granules were plainly visible.

Section 2 was prepared with purified petroleum benzine, chromalum hematoxylin and eosin. This section showed a fibrous connective tissue framework containing fibroblasts and wandering cells and enclosing spaces containing a network of fibers of unknown nature which only partly filled the spaces. In the spaces, as well as in the framework, were numerous eosinophils, some plasma cells and other wandering cells.

Section 3 was treated with purified petroleum benzine and placed in distilled water for five minutes at room temperature. Hematoxylin and eosin were used for staining.

Sections 4, 5, 7, and 8 all appeared alike, though treated differently, and had an appearance similar to that of numbers 13, 14 and 16.

Section 6 was treated with purified petroleum benzine, half-normal hydrochloric acid and hematoxylin and eosin. The homogeneity of the material enclosed within the cellular network was maintained. The diffuse material was not dissolved.

Section 9 was treated with purified petroleum benzine, absolute alcohol and eosin in absolute alcohol. The picture was essentially the same as in section 1. The whole substance in the spaces stained a uniform pink, with the cells in the diffuse material staining a deeper, brighter pink.

Section 10 was warmed over a free flame until charring just began, after which it was cooled. This was repeated several times. It was then prepared with purified petroleum benzine and stained with hematoxylin and eosin. There were a few small round spaces in the homogeneous diffuse material, as if they were produced by shrinkage and retraction. Otherwise, the section was identical with sections 9 and 11.

Section 11 was prepared with purified petroleum benzine and methyl alcohol and stained with eosin in absolute alcohol. The section was similar to sections 9, 10 and 11.

Section 12 was ashed at about 650 C. for thirty minutes. The cellular network contained a uniform, rather dense ash. It enclosed areas showing an equally uniform ash which was, however, less dense. There was no trace of an intricate network within this less dense ash. The cells stood out sharply in the less dense areas by their higher concentration of ash.

Section 13 was treated with purified petroleum benzine, a three per cent solution of sodium chloride for five minutes and eosin in absolute alcohol. The contents of the spaces were stained as in number 2. Nothing was left but the network of fine fibers of unknown composition. The diffuse material in the spaces had been dissolved.

Section 14 was treated with purified petroleum benzine, 2 per cent acetic acid for five minutes, and eosin in absolute alcohol. The observations on section 13 apply equally well to this section.

Section 15 was treated with purified petroleum benzine, absolute alcohol for thirty minutes, a 3 per cent solution of sodium chloride for five minutes and eosin in water. The section presented the same appearance as section 9; the diffuse, homogeneous material enclosed within the cellular network was preserved.

Section 16 was treated with purified petroleum benzine, twentieth-normal hydrochloric acid and eosin in absolute alcohol. The material enclosed within the cellular network presented the fibrillated meshwork appearance described for section 13. The continuous substance was dissolved.

Section 17 was treated with xylene followed by absolute alcohol for two hours, and Weigert's fibrin stain. Both the connective tissue framework and the unknown fibers in the spaces reacted negatively to tests for fibrin, as far as this stain is specific for fibrin.

Conclusions.—The material enclosed within the coarse cellular network is nonprotein because it is denatured by heat and by prolonged contact with alcohol. This protein consists of at least two substances, which have different solubilities. One of these is insoluble in all the reagents used in this investigation and forms a finely reticulated network showing no characteristic pattern. These do not stain with the Weigert fibrin stain.

The other substance is insoluble in ethyl and methyl alcohol, purified petroleum benzine and half-normal hydrochloric acid. It is soluble in water, acetic acid, dilute solutions of sodium chloride, sodium carbonate, calcium hydroxide and twentieth-normal hydrochloric acid.

In addition to these protein substances, the material enclosed within the cellular meshes contains inorganic substances and/or substances which on incineration yield an ash. This is likewise homogeneously distributed through the protein components.

SURGICAL TREATMENT

The patients selected for surgical treatment ranged in age from 21 to 50. In no case was a patient operated on who might even remotely be a poor surgical risk. Those with arteriosclerosis, cardiac disease, tuber-

culosis or hypertension were placed on a nonsurgical regimen. We did not, however, consider bronchiectasis a contraindication unless it was complicated by a cardiac condition. Similarly, children and patients over 50 were placed on nonsurgical regimens except when suppuration of a single sinus, such as the maxillary antrum, had to be remedied. These we had no hesitancy in draining. When complete obstruction of the common meatus by polyposis occurred and a surgical risk was involved, we removed the polyps piecemeal at various sittings, so as to avoid bleeding, shock, etc., but we never actually entered the sinuses, preferring to treat them later with radium. Data concerning the latter group were tabulated with those from our nonsurgical cases, since all of the patients received some subsequent medical therapy.

As previously stated, only radical procedures were done on patients selected for surgical treatment. Forty patients received the benefit of complete exenteration of all sinuses. Forty had intranasal radical ethmoidectomy and the Caldwell-Luc operation on both sides. Fifty had only intranasal radical ethmoidectomy, and twenty with suppurative obstruction had one or both antrums operated on by the Caldwell-Luc technic.

Of the forty patients with total exenteration, sixteen, or 40 per cent, were free from asthma for six months to one year. In these cases we considered the treatment as a failure. The other twenty-four, or 60 per cent, have had two or less attacks of asthma yearly for five years and are easily able to carry on their normal duties. These we considered cured. An analysis of the sixteen failures is of interest.

The peculiar tendency of allergic persons to change from year to year in their sensitivity to allergens is frequently demonstrated. In the group of sixteen for whom surgical exenteration failed, who apparently responded excellently at first to operative treatment but had recurrences, a recheck of cutaneous reactions in some revealed sensitization to numerous allergens which previously had produced a negative reaction. In part, the fault might have been in the technic of the allergists, who at that time, because of the dearth of material and the great number of patients, were making only scratch tests. This, however, was remedied, so that intradermal tests were used almost exclusively and intraconjunctival and intranasal tests on request. In addition, these patients were among those whose condition was classified ordinarily as "intractable asthma." All without exception had decided pathologic involvement in the chest and had been afflicted with asthma almost constantly for from five to twenty years—the youngest was 28 years of age and the eldest 50. In the last two years, five of these patients have died of bronchopneumonia. Two died during the fall hay fever season, when they were

having hay fever and asthma. The increasing severity of hay fever over the past five years has caused endless new attacks occurring among persons previously found normal, so that it has become our custom to request the allergist, particularly for private patients, to use higher concentrations of pollen extracts in all suspicious cases. Twelve of the persons in whom surgical treatment failed were found on a second survey to have cutaneous sensitivity to from two to six allergens. Four of the patients, though giving negative cutaneous reactions to all allergens, on the second survey were aware of being highly sensitive to milk, eggs and various danders. Four patients acquired secondary suppuration and polyposis of the frontal sinuses, so that the operation had to be repeated. In private practice it is our custom to follow up our work with radium, which for the most part prevents disturbing regrowths and subsequent infection. In the clinic, however, our supply of radium has been limited, so that we have used it in only a few of the cases.

Of the forty patients who had intranasal ethmoidectomy and the Caldwell-Luc operation on both sides, eighteen, or 45 per cent, have had two or less attacks of asthma yearly but have been able to carry on their normal occupations without other medication. The remaining twenty-two, or 55 per cent, have had to have supplementary medical aid as outlined later.

Of the fifty patients who have had only intranasal ethmoidectomy, sixteen, or 32 per cent, have had two or less attacks yearly and have been able to carry on their normal occupations. The remaining thirty-four, or 68 per cent, have had to have supplementary medical treatment during attacks.

Of the twenty with suppurative obstruction, twelve, or 60 per cent, have had almost complete relief, i. e., less than two attacks a year, while eight, or 40 per cent, have been compelled to take supplementary treatment.

Summarizing our results from surgical treatment, one will note that of the patients whose sinuses have been totally exenterated, 60 per cent have been cured; when only bilateral ethmoidectomy and exenteration of the antrum were done, 45 per cent were clinically cured; when ethmoidectomy alone was done, 32 per cent were cured, and when one or both antrums were exenterated in suppurative cases, 60 per cent obtained five year relief. In addition to these, thirty-four patients whose age or other conditions made them poor operative risks, received the benefit of only removal of polyps or other minor surgical treatment, plus irradiation. In only three of these patients, or about 9 per cent, was a five year cure obtained.

NONSURGICAL TREATMENT

The patients placed on a medical regimen included one hundred and fifty with border line conditions, who presented early pathologic changes in the nose but not enough to warrant surgical treatment. These included children, patients over 50 and all who were poor operative risks. They had previously given a history of asthma with colds and were proved to react negatively to all allergens. Among these were eighteen children, ranging in age from 3 to 18 years; the remainder ranged in age from 18 to 72.

Sixteen adults with pronounced changes in the chest were given injections of iodized poppy-seed oil without other treatment. This consisted in the instillation of 40 cc. of iodized poppy-seed oil, 20 cc. into each side, by means of a catheter described by us [2] in a previous publication. Injections were made weekly for twelve weeks. The results obtained were excellent during the treatment but were not of lasting value. None remained free from asthma longer than six weeks after treatment was terminated. "Follow-up" roentgenograms of these patients revealed the presence of roentgenopaque material in three patients as long as two years after this treatment. It is possible that this might be harmful to the patient in later years.

A second group of twenty-four patients were treated with instillations of autogenous antivirus into the chest. This was prepared by aspirating material from the deepest bronchi directly into 800 cc. of human serum by means of the aspirating catheter previously mentioned. Human serum was used to lessen the likelihood of reaction to foreign protein. After two weeks' growth the material was passed through a porcelain filter. Then, daily for ten days this was seeded with aspirated bronchial material incubated for twenty-four hours and filtered. It was noted in the preparation that as the material aged it became more and more resistant to the growth of organisms from the chest, owing to the increasing concentration of bacteriophage or lysing materials. It would never, however, reach a stage at which all materials were lysed, apparently owing to the fact that some of these organisms are unable to produce an antivirus or bacteriophage. The material thus prepared was heated to 55 C. for one hour, presumably everything except the antivirus thus being destroyed.

Beginning with 5 cc. instillations into the chest, the dose was doubled every four days until amounts as large as 40 cc. were given at one sitting. Two patients were found who could not tolerate over 10 cc. of material, this amount causing fever, general aches and pains and extreme

2. Fox, Noah, and Harned, J. W.: Aspirating Catheter for the Treatment of Pulmonary Suppuration, Arch. Otolaryng. **18**:819 (Dec.) 1933.

prostration. The others, however, received their full 500 cc. of material as a course of treatment. We found this treatment a promising method for topical applications, far superior to any antiseptic which we had used, though the exact character of the materials is still unknown, even the mechanism involved in the cure being problematic. But whether the result occurs through direct lysis of organisms, by stimulating the so-called reticulo-endothelial system to produce phagocytes or by local production of antibodies, particularly opsonins, it provides the otolaryngologist with a splendid method of policing the recesses of the bronchi reached with difficulty. The results obtained were general improvement in all cases, even those in which toleration of the material was poor. The patients with fetid breath lost their odor after the sixth to the tenth injection. Four, or 16 per cent, were entirely free from asthma for nine months or more, the longest period being thirteen months. Twelve, or 50 per cent, were free from asthma for six months, and the rest had freedom from asthma for from two to five months.

A third group of ten persons were given injections with material taken from asthmatic patients during operation. The material was prepared by grinding freshly obtained human mucosa with sand, allowing it to extract in three volumes of distilled water overnight in the cold, filtering and concentrating it to about one fifth of its original volume. The filtrate was mixed with an equal amount of aluminum cream (colloidal aluminum hydroxide) prepared by the department of physiologic chemistry and was injected in 20 cc. doses into the buttocks. Six of the patients acquired abscesses, which had to be incised. The result was as follows: Three persons, 30 per cent, were free from asthma for from three to five months; none of these patients had abscesses. One patient who had an abscess became worse. The other six were free from asthma for periods ranging from six to ten weeks. Because of the numerous abscesses, this method was abandoned.

Similarly prepared material was passed through a porcelain filter but not mixed with the aluminum cream; i. e., it was freed from organisms. This was injected into twelve persons. Six, or 50 per cent, of these patients were free from asthma for three to six months; two did not respond at all, and the other four were benefited for four to ten weeks but were never totally free from asthma.

Another group of ten patients were given injections of serum taken postoperatively from persons with sinusitis and asthma. We have found that almost invariably there is about three weeks after operation when the patient not only is free from asthma but has a general feeling of well-being. From these patients 100 cc. of blood was drawn and injected into the buttocks of patients suffering from severe asthma.

We thought it possible that a material might develop in these convalescent patients that could be of benefit to those having active asthma. Of these persons, only three were free from asthma for six to ten weeks. The other seven apparently were only slightly benefited. None were made worse.

Seventy-five patients were given injections of pseudoglobulin. The material was prepared as follows: Fresh porcine sinus and nasal mucosa was extracted for twenty-four hours in the cold with a 10 per cent solution of sodium chloride. This was saturated with ammonium sulfate. The precipitate was dissolved in a 10 per cent solution of sodium chloride and dialyzed until salt free. The euglobulin was filtered out. This solution was then half saturated with ammonium sulfate, and the precipitate was dissolved in a physiologic solution of sodium chloride and again dialyzed. When salt free the solution was dried in an air tunnel. The dried protein was made up with a physiologic solution of sodium chloride to dilutions of 1 : 3,000 and injected in progressing doses every day, starting with 5 minims. The maximum dose was 2 cc. When the maximum dose was reached, a daily dose of 2 cc. was given. Since most antibodies are found in the pseudoglobulin fraction of the blood protein, it was felt that this material might be of some benefit through its natural antibody content. Our result with this material on the whole was good. All patients tolerated the pseudoglobulin well, with only a minimum of discomfort at the site of injection. Our results were as follows: Eight patients, about 10 per cent, were completely free from asthma for one year while taking injections. Thirty-two, or about 42 per cent, of our patients were well enough to be able to continue their regular work. Six did not respond at all, but when they returned to the department of allergy for a resurvey they were found to be sensitive to a number of allergens to which one year previously the reaction had been negative. The remaining twenty-nine were benefited enough that of their own volition they continued throughout the year with this treatment.

Six children, ranging in age from 6 to 9 years, all of whom even at this age had perceptible thickening of the nasal tissues, were selected for implantation with radium seeds. Two seeds, each of 1.25 millicuries, were placed under the middle turbinate, one in the anterior ethmoid region and one in the posterior region on both sides. These were left to slough out by themselves. The results obtained were as follows: None of the patients was entirely free from asthma. Two were improved for four months. The remaining four did not seem to be affected.

Statistics on vaccine therapy have been omitted, since this work was done by persons in another department and will probably be incorporated by them in a later paper.

SUMMARY

One cannot compare results of surgical with those of nonsurgical methods, but it can truthfully be said that when surgical relief is obtained, it is likely to be permanent or for a good period. In our hands the best surgical results were obtained when complete exenteration of the sinuses was done.

The treatment of noninfectious bronchial asthma is definitely in the realm of the internist practicing in the field of allergy, while the treatment of the infectious type is just as definitely in the field of the otolaryngologist. Our development, however, has been purely along surgical lines, so that the asthmatic patient who is a poor surgical risk and whose condition is of the infectious type too frequently is either neglected or overtreated surgically. Were he simply a nonasthmatic person with a chronic nasal infection, he would fare better, since numerous methods of treatment would be attempted. The procedures we have described, though in most cases of only temporary benefit, represent our efforts at developing the nonsurgical treatment of infectious asthma.

CONCLUSIONS

In carefully selected patients with infectious asthma complete eradication of the pathologic tissues results in a fair percentage of cures.

Certain nonsurgical procedures applied to those with borderline conditions with a minimum of pathologic involvement will often temporarily alleviate the asthmatic condition.

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INTRATRACHEAL INHALATION ANESTHESIA

A REVIEW OF TEN YEARS' EXPERIENCE, WITH SPECIAL REFERENCE TO ITS FIELD OF USEFULNESS, DETAILS OF TECHNIC AND OBJECTIONS RAISED AGAINST THE METHOD

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In the last twenty-five years intratracheal anesthesia has been hailed as an ideal method, has fallen into disfavor and has returned to be warmly received by those who are familiar with its advantages.

It is interesting to reflect on the reasons for the popularization of this method of anesthesia, the causes of its decline, and, finally, why it has reappeared as a well established permanent technic with an ever widening field of safety and usefulness.

In an article published in 1910, Meltzer stated: "On the basis of my operations and experiments, it seems to me that the giving of ether by the method of intratracheal insufflation is the safest and most effective way of administering this anaesthetic."

In 1911, Meltzer and Auer, of the Rockefeller Institute, published a paper from which they drew the following conclusions: "Dr. C. L. Elsberg was the first to introduce intratracheal anaesthesia in human surgery. In 125 cases, which he reported, there were no pulmonary, bronchial, or laryngeal complications. Post-operative vomiting occurred in only 4 cases. In 3 cases there was some abdominal rigidity. All patients awoke quickly and were comfortable afterwards." Dr. C. E. Peck in a smaller series of cases, observed from April 7 to June 11, 1911, made the following report: Anesthesia was ideal; the color was perfect throughout. Respiratory movements were quiet and regular. None of the patients had postoperative hoarseness, bronchitis, pneumonia or any other postoperative complication which could be attributed to the anesthetic. Dr. Peck stated that he "had been struck by the absence of ether shock or depression." Both Elsberg and Peck reported that for operations on the mouth, pharynx or superior maxillary region, the method was ideal in preventing aspiration of mucus and in securing perfect, quiet anesthesia without difficulty.

It will be observed that these findings are as pertinent today as when they were published.

Why, then, did so useful a method fail in its practical application? Before it is possible to answer this question, it is necessary to consider in some detail the technic employed by Meltzer and Auer and by others

who have used similar principles. First of all, it must be clearly understood that the method practiced was that of insufflation. Insufflation means the introduction of vapor under measured pressure in a volume suitable for the patient's respiratory needs. Provisions are necessary to permit the free escape of this volume of insufflated vapor. This method implies the necessity of a motor-driven apparatus, which must be spark proof and supplied with pressure manometers. It was necessary to employ a small tracheal catheter, along the sides of which insufflated vapor might freely escape. As a result, the operator was continually disturbed by the escaping vapor, which carried with it the odor of the anesthetic. Furthermore, the bulk of the fluid material finding its way into the pharynx was increased by the escaping bubbles. It was originally thought that the deep insufflation of anesthetic vapor into the trachea tended to "wash back" into the pharynx mucus or blood, which might find its way in. As a matter of fact, this did not work out in practice, for the volume of vapor necessary to accomplish this effect further limited the field of operation and interfered with the surgeon.

Magill, of London, England, sought to relieve the difficulty caused by the returning vapor by the simultaneous intubation of two catheters instead of one. One catheter provided means for insufflation; the second, an escape for the insufflated vapor. These catheters were held together by a metal adapter, so that in intubation the operator was required to consider only a single tube. However, the total area of these combined tubes for use in the adult was relatively large (14 mm.), which complicated the act of intubation.

It will be seen, therefore, that however commendable the technic of insufflation may prove to be as to smoothness of anesthesia, muscular relaxation, reduced respiratory excursion in abdominal operations and complete oxygenation, with the resulting reduced venous bleeding, to say nothing of reduced postoperative nausea, nevertheless, these advantages carried the burden of too many complications. It is therefore not surprising to find a gradually increasing resistance to the use of this technic. Direct intubation is a technical procedure requiring practice. The laryngoscopes then available were designed for bronchial rather than for pharyngeal and glottic work. The illuminating element constantly gave trouble. Motor-driven pressure blowers did not, as a rule, supply the volume of vapor required. The best of these blowers occasionally failed, owing to interruption of the electrical circuit or sudden drains on the house current. One can readily appreciate that the sudden cessation of insufflation of anesthetic vapor in the course of an operation on the throat while this delivery was being made through a catheter too small to serve as a respiratory channel for the patient constituted a dangerous accident. Furthermore, pressure manometers were not

always reliable. Finally, the continuous annoyance from escaping anesthetic vapors about the field of operation served to complete the general abandonment of insufflation.

It became clear that if surgeons were to enjoy the benefits of the intratracheal technic, a radical departure must be made from the procedure described by Meltzer and Auer. The area of the combined tubes used by Magill suggested a simple but radical solution of the problem. If the glottis would tolerate a tube 14 mm. in vertical diameter and from 6 to 7 mm. in transverse diameter, was it not possible to introduce a single large tube with a maximum lumen, having a minimum wall, which was not compressible, of a diameter well within the limits of tolerance of the average glottis at any age? In an effort to establish the limit of glottic tolerance, I turned to Dr. Chevalier Jackson, whose personal experience in this field and acquaintance with the results obtained by those who have made use of his equipment undoubtedly constituted a safe and reliable guide. In a personal communication from Dr. Jackson limits providing a wide margin of safety were suggested as follows:

"An infant a few months old can tolerate a 4 mm. bronchoscope which is about 5 mm. outside. In a child of 6 years my associates and I use a 6 mm. bronchoscope, about 7 mm. outside. In an adult, we use a 9 mm. bronchoscope, which is about 10 mm. outside. All the breathing is done through the bronchoscope when a full size is used.

"There is no undesirable reaction of any consequence in an operation of as long as two or three hours. There is vastly more reaction from the bubbling back and forth of the ether-laden mucus when ether is given by the open method."

A trial made a number of years previously had convinced me that a rubber tube required such a thick wall to keep it from collapsing that the lumen was seriously reduced. Furthermore, any rubber tube after several boilings collapses so readily that it becomes an easy matter, through instrumentation, or a change in the position of the patient's head to obstruct completely respiration through it. In a conversation the late Mr. Farr, of the George Tieman Company, proposed the use of a section of the standard bronchoscope as the intubating element, to which was to be attached a coiled wire in the form of a tube which would carry the apparatus out and beyond the patient's mouth. This coiled section of tubing was covered by a thin rubber sleeve making it air tight. During intubation, an obturator was inserted within the tube to keep it rigid. It was withdrawn, after intubation, permitting the free displacement of the tube from one side to the other.

This device eliminated the former complications and objectionable features of the intratracheal technic. In the first place, the entire pro-

cedure is altered from insufflation to inhalation. It is no longer necessary to supply motor-driven apparatus; pressure manometers are unnecessary, and as no vapor is blown into the lungs, it is no longer necessary to provide means for its escape. When a patient is to be intubated, a tube is chosen with a diameter which serves to block the glottic space. Respiration through the tube is further encouraged by placing a gauze pack in the pharynx. This pack prevents blood from the operative field from entering either the trachea or the esophagus. The diameter of the tube provides complete freedom for respiration. This improvement extends, as it were, the position of the glottis from directly beneath the operating field to a position remote from it. For all practical purposes, respiratory obstruction which occurs above the trachea is automatically and completely eliminated. The respiration of each patient may be depended on to be as free as that through a tracheotomy opening. When the chest is to be opened, it becomes a simple matter to prevent collapse of the lung or to cause its distention at will. Any anesthetic agent can be used with the greatest freedom. Operations on the nose and throat and plastic operations on the face can now be done with an aseptic field, since the respirations of the patient no longer converge on it.

One may, with advantage, consider various intratracheal methods which have been proposed to secure the conditions noted and under certain complicated situations a more satisfactory field of operation.

The Magill intranasal technic does away with the necessity of laryngoscopy. A molded rubber catheter is passed through one of the nostrils into the pharynx, and from this position it is introduced into the trachea. The technic requires some practice before facility is acquired. It is of use when there is complete occlusion of the jaw preventing separation of the teeth or in conditions preventing extension of the head. The tube, when inserted, does not offer as large a respiratory lumen as the intratracheal inhalation tube which I have referred to. The soft rubber wall may be compressed by packing and by the pressure of instruments. The technic of introduction is objected to by those who consider it unsurgical to pass a tube first through the nose and then into the glottis. Not infrequently irritation or bleeding of the nasal mucosa takes place because of trauma. When nasal obstruction exists, it may become difficult or impossible to use the technic.

Guedel and Waters have employed a silk woven catheter of large diameter provided with a detachable cuff, which may be placed near the tip and which may be distended after intubation. This balloon blocks the trachea and the glottis and prevents foreign material from finding its way past the tip into the trachea. The occasional occurrence of leaks in the balloon, the fact of pressure on the tracheal mucosa, the increased bulk of the apparatus which must be introduced

beyond the vocal cords and the fact that the balloon does not prevent material from finding its way into the esophagus, constitute objections to this type of intratracheal technic. In skilful hands, however, and in a surgical clinic protected by careful team-work, the method is excellent. A modification of this practice, consisting of packing a bronchus with a small balloon tube when one lung is to be shut off from the general airway, is also employed by Waters and others. This practice is useful in thoracoplasty or in lobectomy when the content of a pulmonary abscess is to be prevented from finding its way into the trachea and into the healthy bronchus of the opposite side.

The choice of the intratracheal technic to be employed depends largely on whether the operator is working at a number of institutions in which he is expected to supply and maintain the necessary apparatus or whether he is carrying on his activities in a university or hospital clinic supported by suitable assistance and trained team-work.

Owing to the fact that I have carried on my work in many institutions without assistance in most cases, often under the most trying conditions of conflicting appointments and frequently with surgeons unacquainted with the technic, I have felt obliged to limit myself to apparatus and technic of the utmost simplicity. As a consequence, I have not employed the balloon technic for either tracheal or bronchial packing. I have depended altogether on gauze which I have placed in the supraglottic and retropharyngeal regions to insure the control of aspiration and to prevent the introduction of foreign matter into the esophagus and the trachea.

The present report, therefore, deals exclusively with the intratracheal inhalation technic devised by me and referred to in previous communications.[1]

The continuous use of this method has brought out certain necessary details of technic essential to its smooth operation. Objections raised by those who are misinformed regarding the background of the technic and who are either unwilling or unable to develop the necessary skill are referred to in detail. Finally, practical experience in the use of the method in a variety of surgical fields is noted.

Postoperative complications which have not been reported to me by the operating surgeon do not appear in this report. It is presumed that if such complications were serious a prompt report would have been received from the surgeon. No mortality, either direct or contributory, has occurred in my personal experience.

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1. Flagg, P. J.: Intratracheal Inhalation: Preliminary Report of the Simplified Method of Intratracheal Anesthesia Developed Under the Supervision of Dr. Chevalier Jackson, Arch. Otolaryng. **5**:394 (May) 1927; Intratracheal Inhalation Anesthesia: The Method of Election for Operations on the Head and Neck, ibid. **7**:156 (Feb.) 1928; Intratracheal Inhalation Anesthesia in Practice, ibid. **15**:844 (June) 1932.

DETAILS OF TECHNICAL PROCEDURE

Instrumentarium.—Laryngoscope: While in practice, the middle-sized laryngoscope will cover the full range of patients to be treated, infants are more satisfactorily handled with the instrument designed for this purpose. For a large adult with an unusually deep pharynx the extra long laryngoscope is occasionally required.

It is my practice to have always available two laryngoscopes, as a light will occasionally fail and cause embarrassment at a critical instant if only one instrument is available. Care must be observed that the blade of the instrument does not become compressed by rough handling, reducing the slot through which the intratracheal tube is released.

Mouth Gags: A Mason gag or a side gag is preferable to a Jennings gag which extends across the face, as the upper blade of the Jennings gag occasionally intrudes on the field of exposure. It is possible to use the laryngoscope and to intubate without a gag. Not infrequently, however, an intubated patient may react sharply and bite into the coil section of the tube, effectively suffocating himself. I make it a practice, therefore, to use a gag when I intubate and to leave such a gag in situ during operation whenever this is feasible.

Intratracheal Tubes: Intratracheal tubes must be prepared and used as sterile instruments. Two tubes covering the approximate size of the patient's glottis should always be boiled and ready for use. Before boiling, the coiled section should be tested to make certain that it is firmly attached to the solid tip. Occasionally corrosion or injury breaks the connection.

Springs made of rustless steel are not subject to this danger. The rubber tubing should cling tightly to the metal through its entire length. Blistering, loose ends or a sticky rubber tube (caused by too much boiling or by oil) should immediately be replaced. If the tube has not been used for some time, one must be certain that the obturator slides freely within it. It is extremely embarrassing to be unable to remove the obturator after intubation.

It goes without saying that the inside and the outside of the tube must be scrupulously clean. This cleanliness can be confirmed by removing the obturator and looking through the tube. It is customary to boil a 5 mm. and a 7 mm. tube for children 6 years and under. For babies, a special 4 mm. tube and the 5 mm. tube are prepared. For all adults, I provide a 7 and a 9 mm. tube. Not infrequently, an adult with a large glottis easily accommodating a 9 mm. tube will offer difficulties of exposure, necessitating the use of the 7 mm. tube, ordinarily used for a 6 year old child.

Connecting Tubing: A connecting tube uniting the intratracheal tube and the source of the anesthetic should be of such length that it removes the operator from the field but at the same time does not offer respiratory resistance or too much rebreathing. A tube 20 inches (50 cm.) long, with an internal diameter of ½ inch (1.25 cm.), the wall of which does not readily collapse or become compressed, should be used.

Source of Anesthetic Vapor: When the ether can inhaler is used, it is customary to make three holes in the cover, covering a total area approximately ½ inch (1.5 cm.) square at 12 o'clock, 8 o'clock, and 4 o'clock. A can of ¼ pound or ½ pound size is satisfactory. A new can is used each time. This can is sterile in its inside surface, and owing to the paper cover it does not become covered with moisture and slippery in the operator's hands. When the source of vapor is a rebreathing bag or a closed system of any sort, one must avoid making positive pressure in this system, unless this is indicated, as in thoracoplasty or for resuscitation. The intratracheal tube is designed almost to fill the glottis. Prolonged positive pressure causes ischemia of the bronchial mucosa and low grade asphyxia.

Suction Apparatus: Too much emphasis cannot be placed on the matter of suction. Suction must be supplied with a vacuum of at least 15 to 20 pounds (6.8 to 9 Kg.). It must be continuously available from the beginning of the anesthesia. The mouth suction tube used before intubation should be operating satisfactorily. The intratracheal catheter which is passed as required into the intratracheal tube for suction after intubation must be of such size that it will not obstruct respiration through the tube while suction is being performed. For the 7 and 9 mm. tubes an open end catheter not larger than a no. 14 French catheter should be employed. For the 5 and 4 mm. tube a no. 8 French catheter is indicated. If a larger catheter is used and the intratracheal inhalation is blocked by it, the respiratory effort of the patient, unable to operate through the tube, will produce powerful suction on whatever fluid may be in the pharynx and cause this to enter the glottis along the sides of the tube.

Pharyngeal Pack: A 2 inch (5 cm.) pack with selvedged edge from 12 to 36 inches (30 to 91 cm.) long is used for hypopharyngeal packing. This gauze is placed, after intubation, under direct vision. It is moistened with liquid petrolatum or with a physiologic solution of sodium chloride.

Oxygen and Carbon Dioxide: These gases should always be available for resuscitation and supportive purposes.

DETAILS OF PROCEDURE

It has been repeatedly pointed out that laryngoscopy and intubation with general anesthesia and complete relaxation are so much easier to

perform than are laryngoscopy and intubation with local anesthesia that the two procedures can scarcely be compared. This is true, however, only when complete relaxation and control of the reflexes have taken place. There are all degrees of resistance to laryngoscopy and intubation between the ordinary conscious state and that of complete anesthesia. The expert in peroral endoscopy can meet these difficulties with a minimum disturbance to his technic. The inexperienced beginner is certain to run into all manner of difficulty unless this requirement is scrupulously observed. It is possible, and it is indeed the practice of a number of operators, to perform laryngoscopy and intubation with local anesthesia alone, with the basal anesthetics alone, with nitrous oxide and oxygen, with ethylene or with cyclopropane, either in combination with cocainization of the glottis or without such assistance. The reason advanced for this technic is avoidance of the occasional delay and difficulty of securing complete relaxation and abolition of the reflexes by ether.

In private practice, when the maximum responsibility is placed on the anesthetist in every case and minor trauma, likely to be overlooked or ignored in a hospital clinic, is carefully observed and often enlarged on, it is unpractical, if not impossible, to assume the risks implied by rapid intubation without ether. When one is daily performing laryngoscopy and intubation of patients presenting social and pathologic complications, there appears to be no short cut to a deliberate procedure in laryngoscopy and intubation. I have found that the use of morphine and atropine as a routine preliminary in such cases almost invariably delays the progress of induction and the onset of relaxation. Tribromethanol in amylene hydrate, when indicated, shortens induction and increases the ease of exposure and intubation. Evipal (n-methylcyclohexenylmethylmalonylurea) in doses of 10 cc. is of little assistance in securing a satisfactory field. Care must be taken during induction when the artificial use of carbon dioxide is employed to hasten induction that the patient is not overstimulated, for promptly after intubation he is likely to fall into an alarming period of apnea on the withdrawal of the rebreathing.

The routine procedure is to secure a smooth gas-oxygen-ether induction to a point at which pharyngeal reflexes are not elicited when pharyngeal suction is carried out and at which the teeth may be separated by the operator's fingers without difficulty. In extremely resistant patients it is helpful to complete laryngoscopy and intubation with the assistance of an ether vapor hook, through which ether vapor is allowed to flow during intubation.

The condition of the patient's teeth must be carefully observed before anesthesia is started. Pivot teeth, porcelain inlays, teeth loose in their sockets and fixed bridges present hazards which must be estimated and which must be met at the time of laryngoscopy. The best protection,

of course, from all such hazards is complete relaxation of the field, through which laryngoscopy must be done. The edentulous patient will sometimes offer the complication of a field which is so easy to expose that intubation is done before the glottic reflexes are well anesthetized. This results in severe spasm, apnea and cyanosis. These are not in themselves dangerous, but they are distressing to the onlooker and disturbing to the anesthetist. Occasionally in a partially edentulous patient, a solitary posterior molar may intrude into the slot of the laryngoscope without being observed, effectively preventing intubation. I recall two cases in which I suffered this embarrassment. As the slot of the laryngoscope is to the right, the tongue is displaced to the left of the laryngoscope and above it during exposure. Should exposure be attempted on the left side of the mouth the tongue will fall into the slot and obstruct the vision. It must be borne in mind that the intubation tube contains an obturator, which is perfectly straight and which has a large enough lumen to permit direct vision through it.

Before laryngoscopy is attempted, the pharynx and the hypopharynx must be completely evacuated of all fluid, mucus, saliva and vomitus by means of suction.

The patient, with the head slightly extended and the teeth partially separated by a side gag placed on the left side of the mouth, lies flat on the table. The laryngoscope held in the left hand is passed over the dorsum of the tongue. At the same time the right hand makes pressure on the patient's forehead, gradually extending the head. The epiglottis then falls into view just beyond the tip of the laryngoscope. With the head in complete extension, the epiglottis is caught by the lip of the laryngoscope and lifted upward. In this maneuver the upper teeth must not be used as a fulcrum; the lifting motion should extend over the whole blade of the laryngoscope at once. An effort to pry the epiglottis upward, using the teeth as a fulcrum will result in damaged incisors or, in the case of artificial teeth, in broken dentures. If the patient's neck is short and thick, considerable difficulty will be experienced in getting a good view of the glottis. In these cases it will be of assistance to make exposure over the bicuspids or the anterior molars. When the patient is thin, quite the contrary is the case. A complete exposure of the glottis is possible, with full relaxation. On exposure the vocal cords will be seen to move with respiration, separating on inspiration and coming together on expiration. In difficult exposures it is well to time intubation to take place during inspiration. Care must be taken not to touch the vocal cords with the tip of the intubation tube in a false attempt to intubate. Such contact immediately throws the glottis into spasm, making it necessary to return to the inhaler for reanesthesia.

It must be pointed out that each detail of the armamentarium must be in an accustomed position and immediately available, in order that the technic may be timed smoothly. Delay, hesitation or hunting for odds and ends after exposure of the glottis is bound to result in complications.

Before the intratracheal tube is inserted into the glottis, the tip is lubricated with liquid petrolatum or some other sterile lubricant. I do not feel that the danger of fat embolus can compare with the trauma caused by a dry tube, especially in the face of spasm. The necessity for this technic was brought home to me shortly after I began intratracheal intubation. The patient was a thin woman with large anatomic structures which were so easily exposed that the glottis was demonstrated to by-standers before intubation was performed. Intubation with a dry tube was done against laryngeal resistance. A postoperative laryngoscopy revealed an abrasion of the mucosa of one vocal cord. This abrasion unfortunately became infected from posterior pharyngeal discharge, resulting in prolonged discomfort and partial apnea. It is a relief to report that in the last eight years, owing to adequate lubrication of the tubes and avoidance of spasm, this trauma has not been repeated.

In patients difficult to intubate, when the exposure has not been entirely satisfactory, the position of the intratracheal tube is sometimes open to question. In these cases one must clearly hear the respirations passing through the tube before one can be satisfied that the tube is not in the esophagus. This question is not likely to be raised when exposure is good. Once the tube has been inserted and the patient has been found to breathe through it, it should not be withdrawn, regardless of the cough or spasm which it may provoke. Too early intubation may result in apnea, with marked cyanosis. This can immediately be relieved by blowing oxygen directly into the intratracheal tube. To withdraw the tube in such cases is to be faced by a subsequent spasm which may not be easy to control. After intubation, the trachea is sucked clean of any aspirated mucus by the suction catheter passed directly into it. The connecting tubing is then attached, and the anesthetic is rebreathed. The pharyngeal pack is then applied. It has been my experience that dry gauze in contact with the pharyngeal mucosa even for a short period results in sore throat, of which a patient will complain bitterly. I have had an opportunity to reanesthetize patients who have suffered from this embarrassment and to eliminate all discomfort by thoroughly saturating the pack with liquid petrolatum. English anesthetists make use of an ordinary solution of sodium chloride to effect the same result. In applying the pack, care must be taken that it is not applied under the tongue instead of over it. It is easy to make this mistake when the mouth is small and when the patient presents some spasm. Energetic

packing beneath the tongue will result in damage to the frenum, which may be discovered only after the operation. The pack is placed deep in the pharynx, so that not only the trachea but also the esophagus is protected from the entrance of fluid. The blocking of the esophagus appears to contribute to the reduction of after-sickness which characterizes this type of anesthesia.

I have made it a practice to rely on the ordinary ether can inhaler. By closing two of the holes in the top of the can, the tidal volume of the respiration can be closely estimated, and the position of the tube determined. Should the intubation be too deep, the tube will enter one of the bronchi, thereby reducing the volume of the respiration by half. Mucus in the trachea and within the tube registers as a bubbling sound and may readily be removed without disturbing the field of operation.

After intubation, when the operation promises to be long or when induction has been stormy, ⅙ grain (10.8 mg.) of morphine may be given hypodermically. This medication immediately reduces the amount of the anesthetic to be used, quiets the respiration and the reflexes and has largely been disposed of by the time the patient has been returned to bed. It will be found helpful in many cases to give oxygen along with ether vapor. Such administration serves to check the color, particularly when so-called daylight artificial illumination is used.

After the equipment for this type of intratracheal anesthesia had been designed and after the first few hundred patients had been anesthetized, I was impressed by the simplicity of the technic, its freedom from complications and the uniform results obtained. Later experience has emphasized the fact that while the technic is simple the necessary details must be scrupulously carried out in every case or a great variety of embarrassment may result. With the reservations mentioned, I have not the slightest hesitation in recommending the technic as a routine to all engaged in the practice of anesthesia.

Intratracheal inhalation anesthesia removes the operative field from a supraglottic to an extraglottic position. In other words, instead of the operation taking place over the opening of an unprotected well, which is the trachea, it takes place around the walls of a well, thereby eliminating the hazard of aspiration of foreign bodies. Operations on the posterior portion of the pharynx, the tongue or the sinuses assume the same relation to the airway as does the operation on glands of the neck, thyroidectomy or mastoidectomy. Not only is the relation of the field of operation to the airway completely altered, but the entrance and exit of anesthetic vapor are removed from the site of operation. I have frequently regretted a failure to intubate a patient, but I never regretted having done so.

OPERATIVE FIELDS WHICH ARE DISTINCTLY BENEFITED BY INTRATRACHEAL INHALATION ANESTHESIA

Operations on the Brain.—Patients anesthetized for decompression, cerebral and cerebellar abscess, tumor, etc., should be controlled by an anesthetic agent and a technic which do not cause an increase in the bulk of the brain through an increase in its blood content. Ether, under ordinary conditions, is contraindicated for this reason. Tribromethanol in amylene hydrate has become popular because it is not accompanied by engorgement of the blood vessels. This anesthetic alone, however, presents a margin of safety which depends altogether on respiratory freedom. Tribromethanol in amylene hydrate supplemented by nitrous oxide and oxygen is likely to result in venous engorgement common to this sequence. Tribromethanol in amylene hydrate followed by intratracheal intubation and intratracheal inhalation anesthesia maintained by ether vapor does not present the objections commonly offered to the use of ether in this field, for the reason that all venous congestion is automatically disposed of. In addition to offering a field free from congestion, the intratracheal technic provides the ideal assembly for immediate artificial respiration, should pressure on the respiratory center or some other cause of respiratory failure develop. I have maintained artificial respiration in a depression of the central nervous system from a cerebellar abscess over fifteen hours. While the patient finally died from circulatory failure, the element of asphyxia due to cessation of respiration was entirely under control. Intratracheal anesthesia permits an aseptic field for operation. Vomited material under these conditions remains in the pharynx and does not add to the patient's danger, as is frequently the case when the trachea remains unprotected.

In the patient who is moribund before operation or the patient unconscious from concussion or from some other form of cerebral trauma, intubation may be performed with a minimum amount of anesthesia. The technic in these cases is directed primarily to the maintenance of the patient's respiration or his resuscitation during operation.

Operations on the Eye.—While operations such as iridectomy, removal of cataract and enucleation in adults can be done satisfactorily with morphine and atropine, followed by pharyngeal inhalation of ether, intratracheal inhalation may be used to advantage and is positively indicated whenever a patient has had a meal or it is suspected that he has food in his stomach.

For operations on children for squint there is nothing that can take the place of intratracheal inhalation anesthesia, from the point of view either of safety to the patient or of satisfaction to the surgeon.

Children, as a rule, the acidotic excepted, present little postoperative reaction to ether anesthesia. This is particularly true when anoxemia has been avoided. Furthermore, in operations on the eye, venous engorgement through respiratory obstruction, whether by the relaxed muscles of the air-way or by tracheal or bronchial mucus, are prone to increased bleeding from venous congestion. Intracheal inhalation anesthesia permits repeated aspiration of tracheal and bronchial mucus in the course of the operation. It permits to and fro respiration without obstruction and the ready addition of oxygen vapor should respiratory depression develop. Little children are prone to come to operation with something in the stomach, especially if the afternoon is set for the operation and the patient arrives at the hospital in the morning. A child placed flat on its back and covered by draperies who suddenly begins to vomit is in serious danger from aspiration. (The aspiration of vomited material by such a child, with subsequent continuous cough and a temperature of 105 F. followed by spontaneous relief, was one of the reasons for the development of the technic herein described.) It is almost impossible to remove the draperies and to apply suction to clear the airway before the first respiration following vomiting takes place. I make it a rule to intubate all children who may have had a recent meal.

In one instance of operation in the home for mastoiditis, word was received after anesthesia had begun that the patient had had a recent meal. It had not been my intention to perform intubation. However, on my learning the condition of affairs, intratracheal tubes were prepared while the anesthesia was being induced. He was then intubated, and the operation went along uneventfully for some time (forty minutes). At the end of that time, the respirations became slow and shallow, and without further warning he vomited, filling his mouth and pharynx with undigested pieces of potato and green peas. During and after this attack of vomiting, the respirations came through the tube clearly, without any interference. The tube, effectively blocking the trachea, prevented aspiration. At the conclusion of the operation, the mouth and pharynx were deliberately examined, the vomited material was removed and the tube was withdrawn. Subsequent recovery was uneventful.

I do not hesitate to anesthetize a patient who has had a meal should indications for emergency operation be present. Under these conditions induction must be rapid, a mouth gag and ether vapor must be promptly used to complete relaxation and powerful suction must be continuously available from the beginning of the anesthesia. Once the intratracheal tube has been placed, the element of danger from vomiting is eliminated.

Operations on the Sinuses.—I know of no technic which can compare with intratracheal inhalation for operations on the nose and its accessory sinuses. The posterior plug used in the ordinary pharyngeal insufflation not infrequently leaks or is misplaced by muscular action in the pharynx. Unless suction is continuously applied below the pack, such material is

sure to be aspirated. With the intratracheal technic no posterior plug is required; the hypopharynx and the region above the glottis are packed, effectively preventing the entrance of blood and other foreign material into the trachea or the glottis. The respirations through the tube reduce venous congestion, and consequently hemorrhage from the field of operation is lessened. After operation the pharynx may be deliberately inspected for foreign material or blood clots before extubation. On several occasions small cotton plugs and dental tampons have been discovered in the pharynx before the tube was removed. In one case the posterior tip of a turbinate was found to have slipped into the posterior part of the pharynx, back of the pack. Blood clots frequently form above the posterior plug in the ordinary technic. When the plug is removed, these may or may not come down into the pharynx. Careful inspection of this region and removal of such clots before extubation are possible with the postoperative use of the laryngoscope.

Tonsillectomy.—The use of intratracheal inhalation anesthesia for tonsillectomy presents a certain degree of difficulty to surgeons who are unaccustomed to the technic. The tube constitutes a foreign body in the mouth, which disturbs some operators. This objection is particularly true in adults with restricted airways or in children. However, when the operator becomes acquainted with the use of the intratracheal technic and learns to displace the tube into the substance of the tongue, and to the opposite side of the pharynx, he finds comfort in the absolutely quiet and fixed field in which he may operate. There is nothing that compares, even remotely, with this field for silence and freedom from anesthetic vapor except the field secured by chloroform.

In addition to the advantages offered by this method, there are the added safety of ether, the safety provided by an airway which can be guaranteed to function, complete oxygenation and reduced venous congestion as well as protection against aspiration. The operator who first uses this technic is somewhat alarmed by the fact that no respiration takes place within his field of operation. The tongue is displaced and held in whatever position he may desire without regard to the usual respiratory needs of the patient. Danger from a sudden unexpected hemorrhage and the aspiration which is likely to follow is quite eliminated. However, I believe that the use of intratracheal inhalation anesthesia for tonsillectomy is distinctly a matter of team-work and should not be urged when the operator sees no advantage in its employment.

Oral Surgery.—In the entire range of anesthesia, there is probably no field more difficult to control than that offered by oral surgery. The repeated pressure made on the airway regardless of the patient's respiratory needs and the continuous presence of hemorrhage, small

particles of foreign matter, teeth, cotton and gauze wipes, etc., render anesthesia hazardous. Pharyngeal insufflation by nasal catheters is usually employed to meet these difficulties. This technic, however, is but a makeshift when compared with the safety and the efficiency offered by the intratracheal tube. The oral surgeon who becomes accustomed to intratracheal anesthesia finds it impracticable to work without it. The safety of the field is apparent, the lack of spasm, the freedom to manipulate the head and the soft parts in any way he may wish without reference to the respiration, and the reduction in venous oozing all contribute to a comfortable field.

On the other hand, however, this field often presents difficulties complicating laryngoscopy and intubation. Not infrequently there are trismus, an infection of the airway, loose teeth or artificial dentures which must be respected. Postoperative laryngoscopy must be done as a routine to eliminate the presence of foreign material before extubation. It is practical in some cases to use tribromethanol in amylene hydrate as a preliminary medication before intubation. Morphine or atropine, however, given before operation usually causes delay and embarrassment. Evipal (n-methylcyclohexenylmethylmalonylurea) in the dosage ordinarily employed does not provide enough relaxation or control of reflexes to be of assistance.

Infections of the Airway.—While it is customary to discourage the use of a general anesthetic in infections of the airway, it occasionally becomes necessary to control the patient by this means. Local anesthesia is not without danger in such cases, for muscle tone which may have served to hold open a restricted airway may suddenly fail, resulting in complete obstruction and death unless relief is immediately available. In all deep infections of the airway involving the hypopharynx, the nasopharynx and the tonsillar region it is my practice to use a deliberate and gradual induction by chloroform vapor and to use the laryngoscope as early as it is practical while the patient is under the influence of this vapor, inserting the largest tube which can be easily introduced between the vocal cords. Not infrequently, edema of the arytenoid cartilages obscures the view of the glottis. One must then depend on familiarity with the field to estimate the point of intubation. A tube of the size used for infants placed between the vocal cords of an adult with obstructed air passages will provide sufficient relief to permit operative intervention. A no. 7 tube will allow complete comfort and safety.

REPORT OF A CASE

Operation for thyroglossal cyst complicated by edema of the glottis.

The patient was a man aged 31. The operation was complicated by hemorrhage which could be checked only by packing. A second attempt to stop the hemorrhage was unsuccessful, and the area had to be packed once more. The situation

was discussed before operation, and it was recommended that the basal anesthetic proposed be eliminated and that no medication be given before operation. There appeared to be no respiratory obstruction or any evidence of edema of the pharynx or the larynx before anesthesia was begun. It was learned, however, shortly after the induction of anesthesia with nitrous oxide, oxygen and ether that the patient had had ¼ grain (16.1 mg.) of morphine and 1/150 grain (0.4 mg.) of atropine. Shortly after induction, difficulty was experienced in ventilation. Extension of the jaw and introduction of a pharyngeal tube did not afford adequate relief. The patient was removed to the operating room, and shortly afterward the respiration became completely obstructed and cyanosis developed. Efforts to relieve the cyanosis by extension of the jaw and manipulation of the pharyngeal tube were entirely unsuccessful. An emergency laryngoscopy was therefore performed. Inspection revealed a mass of edematous tissue in the region of the glottis. It was impossible to orient the glottis or the vocal cords. Orders having been given for preparation for a tracheotomy, intubation was done in the region where it was assumed that the glottis would ordinarily be found. On intubation, the patient made a respiratory effort, but it was believed that this effort had taken place along the tracheal tube which, it was feared, had passed into the esophagus. The laryngoscope was retained in position, and the tongue was supported with a view of encouraging subsequent respiratory efforts. It was then found that the intubation had been correctly performed and that the patient was breathing through the tracheal tube. The pharynx was then packed, a mixture of oxygen and carbon dioxide was given by the intratracheal tube, and the ether inhaler was attached.

The course of the anesthesia for the hour which followed was entirely uneventful, the color being bright, the pulse of good quality, and the patient without sign of spasm. When the carotid artery on the right side was ligated by a temporary loop ligature, the effect was immediately noted in the temporal pulse of that side. The bleeding apparently issuing from the left side, the left carotid artery was then secured with a loop ligation, and tension was made on the ligature. Tension immediately reduced the temporal pulse on the left side, indicating control of the circulation. This was confirmed by the removal of the packing and control of the hemorrhage.

At the conclusion of the dressing laryngoscopy was performed with the intratracheal tube in position. The epiglottis appeared normal, the anterior commissure showing freely above the tube and the cords being apparently free from edema. In view of these findings, the tube was removed for a short time and the patient breathed in a satisfactory manner. Progressive obstruction then developed which was not relieved by extension of the head or introduction of the pharyngeal tube. Laryngoscopy was again performed with the patient lying on his side, and in this position the intratracheal tube was replaced.

The edema encountered in the first intubation may have been occasioned by the hemostatic bandage and deep packing. Much of this swelling seemed to have disappeared by the end of the operation.

The patient was returned to the ward with a Jennings mouth gag in place, to which was attached the tracheal tube. Medication was omitted, and the patient was allowed to recover. The chief discomfort experienced was from the presence of the mouth gag, the tube evidently being well tolerated. The following morning at 11 o'clock, medication was ordered, ⅙ grain (10.8 mg.) of morphine, and the Jennings mouth gag was replaced by a rubber prop.

The patient subsequently died, apparently from circulatory failure.

The visiting laryngoscopist at the institution in which this anesthesia was administered made the following comment: "In my opinion, death was due to shock, resulting from the profuse hemorrhages. I feel that without the technic employed the attempt to save this patient's life would have resulted in death on the operating table."

The safest method of opening a posttonsillar abscess is to expose the airway, as the patient lies flat on his back with his head in complete extension; with local anesthesia or none the incision into the abscess is immediately followed by the insertion of the suction tube into the incision. The position of the head will tend to drain escaping contents of the abscess into the posterior part of the pharynx away from the glottis. There will be no anesthesia of the glottis or the vocal cords from a local anesthetic draining downward. The cough reflexes will be retained. The laryngoscope serves as a mouth gag in this technic, permitting uninterrupted exposure.

Operations for Harelip and Cleft Palate on Children and Adults.—Anesthetization of small infants and babies for operations for harelip presents the difficulty that anesthesia sufficient to give complete control narrows the margin of safety. Light anesthesia in which reflexes are retained, while protecting the patient, embarrasses the operative field by cough, spasm and vomiting. It has been my experience that for children and young babies laryngoscopy and intubation should regularly be performed for this purpose. The anesthesia may then be maintained with a minimum amount of anesthetic, since cough, spasm and anesthetic vapor cannot interfere with the field, as it is administered and received at a distance from it. The 5 mm. intratracheal tube may be used for infants from 1½ years upward and the 4 mm. tube may be used for younger infants.

In this connection, there is a large and accumulating experience of laryngoscopy and intubation of infants for resuscitation which provides a measure of the tolerance of the baby for intubation.[2] A tube of the size specified is well tolerated by the infant. On extubation, the cough reflexes return immediately, and the baby suffers the minimum aftereffects of the anesthetic.

Two infants treated within the last year illustrate the practical value of this technic for operations about the mouth and eyes. One infant 6 months old was given intratracheal inhalation anesthesia for an operation for hemangioma of the eyelid. Anesthesia lasted one hour. Control was perfect. There was no untoward reaction whatever to intubation. Within two hours the infant took 4 ounces (118 cc.) of a formula of half its usual strength.

The second infant was 3 months old and underwent laryngoscopy and intubation for an operation for harelip. Anesthesia lasted forty minutes. Immediately

2. McGrath, J. F., and Kuder, Katherine: Resuscitation of the New-Born, J. A. M. A. **106**:885 (March 14) 1936.

after extubation, the baby coughed violently two or three times, cleared its trachea completely and was returned to its crib, and two hours later it took its usual formula, one-half strength (fig. 1).

I am satisfied that intratracheal intubation as a routine practice in operations on infants is nontraumatic when carried out deliberately under proper precautions by an experienced operator, that it provides the greatest safety for the patient during operation and that it is followed by the least after-effects. Not only is this technic available for operations about the head and neck in infants, but it may be used with marked advantage in abdominal operations, in which it is notoriously difficult to secure and maintain satisfactory abdominal relaxation. The intratracheal tube in situ protects the infant against the aspiration of milk curds which may have remained in the stomach after its last meal.

Fig. 1.—An infant 3 months old with a 4 mm. tube in place for an operation for harelip.

Operations About the Neck.—In operations such as those for thyroglossal cyst, thyroidectomy, disease of the glands of the neck or of the jugular vein and complications of the mastoid, the presence of the intratracheal tube permits complete freedom on the part of the operator in his manipulation of the field. Complete extension or flexion of the head does not affect the respiration. Neither does torsion or pressure of clamps and packing pressing on the trachea. In patients with a large tumor of the thyroid gland, collapse is not infrequent. This collapse of the trachea occasionally occurs during operation or postoperatively. The danger of such an accident is overcome by the presence of the tube, which permits free ventilation past the point of obstruction. One of the serious complicating factors in surgical intervention on the thyroid gland is the low grade anoxemia resulting from nitrous oxide-oxygen anesthesia, from pressure of the tumor or from the operator's manipu-

lations. It is likely that this anoxemia has frequently contributed to cardiac failure on the table. The insurance of free ventilation during the period of operation protects the patient from such complications and increases his margin of postoperative safety. In intubating the patient having a thyroid tumor, allowance must be made for distortion of the trachea by either suprasternal or substernal pressure. Care must be taken in intubating patients when such distortion of the trachea is marked, that the intubation is not made with such vigor as to injure the distal concavity of the curve of the trachea. A special tube with a short tip is available for such cases. Once the patient is intubated, however, the operator experiences complete freedom in his manipulation of the thyroid gland and the tumors associated with it. Traction frequently gives rise to stridor and laryngeal obstruction. When a patient is much embarrassed by a substernal tumor of the thyroid gland, relief is provided until such a tumor is delivered. The intratracheal tube provides a distinct element of protection after severe and uncontrollable hemorrhage of the large vessels of the neck. Control by pressure under these circumstances can be applied without tracheal obstruction. Occasionally, laryngeal edema develops in operations about the neck. A tube in situ in such cases obviates the necessity of emergency tracheotomy.[3]

As a preliminary step, when deliberate tracheotomy is to be done, the operation may be carried out with safety and with complete leisure when a preliminary laryngoscopy and intubation are done. There is no danger of sudden asphyxial obstruction developing in such a case. It is seldom that a patient who is to have a tracheotomy, other than in an emergency for obstruction, cannot be submitted to laryngoscopy and intubation with at least an infant-sized tube. Laryngoscopy and intubation in which the intratracheal tube is retained over the period of acute infection is a safe practice.

Operations on the esophagus are also facilitated by the intratracheal tube. A difficult esophagoscopy for a foreign body or for removal of tissue for biopsy is rendered safer by the presence of an intratracheal tube.

Plastic Operations About the Face and Neck.—The safety of the intratracheal technic with ether anesthesia over long periods, from four to five hours, and an absolutely quiet field without cyanosis, permits the surgeon complete freedom in his manipulations and provides a field

3. A patient with malignant disease of the right vocal cord was operated on, straight chloroform anesthesia being used. Diathermy was employed, and a Haslinger suspension was arranged. At the conclusion of the operation, subcutaneous emphysema was noted. Immediate intubation was performed, and ether was administered intratracheally while tracheotomy was deliberately performed. Immediate recovery was uneventful except for postoperative symptoms of jaundice.

as nearly aseptic as it is possible to secure. Requirements for this type of surgical procedure are critical in the duration of the anesthesia, the necessity for the control of all reflex movement and the prevention of even low grade anoxemia. Healing of tissue in skin grafts and in dressings applying pressure is handicapped when there has been continued cyanosis or when the patient's postoperative reaction is such as distinctly to depress the respiration and the circulation. The use of the basal anesthetics, while providing an agreeable induction, is likely to be followed by a long postoperative period of depression and consequent anoxemia. Nitrous oxide and oxygen used for maintenance over long periods increases the capillary oozing and when used without morphine and atropine in maximum doses is not infrequently accompanied by undesirable reflex movement. For this reason, I have not felt attracted to the newer anesthetic agents and the basal anesthetics for this type of work.

Operations on the Lungs.—Operations for thoracoplasty, lobectomy, abscess of the lungs, etc., are done with greater safety and freedom with an intratracheal technic. The reduction of the absorbing area of the lung, resulting from disease, indicates the need of maximum oxygenation at all times. It is difficult to secure such maximum oxygenation with nitrous oxide or ethylene. Ether vapor, however, in low concentration provides an ideal agent, since it does not cause irritation and provides perfect oxygenation and a wide margin of control. When sputum is present, as in acute tuberculosis or in chronic tuberculosis with abscess, I prefer intratracheal inhalation anesthesia to the intratracheal insufflation recommended by McKesson and others. The reason for this is that the positive pressure within the intratracheal tube tends to keep the secretions out of reach of the suction catheter. Furthermore, the positive pressure embarrasses expiration. Cough in such cases is to be encouraged in order to bring the blood or mucus which may have been aspirated into the bronchi within reach of the suction catheter.

In university clinics where team-work has been perfected, the bronchial balloon of Waters and Guedel may be employed with benefit. When a double thoracotomy is to be done and positive pressure is to be applied to the exposed lung, this may easily be accomplished by allowing pressure to accumulate within the intratracheal inhalation tube by attaching it to a rebreathing bag or by allowing oxygen to run into one hole of the can and stopping the other two holes with the fingers, as occasion requires. The exposed lung does not offer much resistance to distention (6 to 8 mm. of mercury). Such insufflation is different from that required for artificial respiration within the closed chest.

Operations on the Chest.—Operations on the chest wall or on the breast are done with greater freedom with an intratracheal technic owing to the removal of the anesthetic from the field.

Abdominal Operations.—Ordinarily it is not necessary to use an intratracheal technic for abdominal operations. The exceptions to this rule are those for intestinal obstruction or an emergency operation on a patient who has had a recent meal. Many patients undergoing operation for intestinal obstruction have died by drowning in their aspirated gastric contents. Such accidents can be easily avoided by the use of the intratracheal tube. Certain operators find it an advantage to use intratracheal inhalation anesthesia as a routine in abdominal operations. The reason advanced is that the relaxation closely approximates that secured by spinal anesthesia. The respiratory excursions are reduced, and straining is impossible owing to the fact that the patient cannot close the glottis and therefore cannot exert pressure on the diaphragm by air held in the lungs. There is no objection to using intratracheal anesthesia for abdominal operations except that it implies additional instrumentation. From the point of view of the anesthetist the abdominal operation provides the easiest imaginable field for intratracheal anesthesia. The patient can be thoroughly relaxed at leisure and intubated at will, and the entire field of laryngoscopy and intubation remains isolated from the field of operation. It is not unlikely that the popularization of intratracheal anesthesia for the conditions in which it is specifically indicated will broaden into its wider use for general surgical procedures.

OBJECTIONS TO THE TECHNIC OF INTRATRACHEAL INHALATION ANESTHESIA

All manner of objections have been raised to the intratracheal technic. Most of these have been made in good faith, some with an apparent intention of discouraging the use of the technic. In view of the fact that it is sometimes difficult to distinguish between a reasonable objection and one which is absurd, every objection which has been brought to my notice is briefly considered.

Method is Old, Tried and Abandoned.—In this objection, the intratracheal insufflation technic of Meltzer and Auer and other insufflation procedures have been confused with the simplified inhalation technic described. I am not aware of any proof advanced to indicate that the technic has proved unsafe, inefficient or very uncomfortable for the patient. With ordinary technical skill, aseptic care and familiarity with anesthesia, a satisfactory result may be expected.

Trauma to the Pharynx, Vocal Cords and Trachea.—Before the use of liquid petrolatum in the pharyngeal pack, patients complained fre-

quently of sore throat after intratracheal anesthesia. I am satisfied that this irritation was caused by the hygroscopic effect of dry gauze on the pharyngeal mucosa. Irritation of the vocal cords has been conspicuous by its absence. With the exception of the case referred to in which infection followed abrasion of the glottic mucosa and in one instance in which a difficult intubation in a child between 1 and 2 years of age was followed by stridor for a few hours, irritation of the glottis has not been reported. In fact, I have been struck by the tolerance of the vocal cords to instrumentation. I believe that the routine use of liquid petrolatum on the intratracheal tube acts as a safeguard against abrasion of the glottic mucosa. In operations lasting from three to four hours, patients occasionally complain of a sense of soreness under the sternum from the presence of the intratracheal tube. Displacement of the tube at intervals during anesthesia reduces a tendency to contact at one point and obviates this difficulty. In comparison with the protection offered by the technic in the cases in which it is indicated, I do not feel that such objections seriously militate against the method.

Injury to Teeth.—The protection of the teeth turns on the operator's technic, skill and ability to anesthetize a patient to a point of relaxation. China crowns or porcelain dentures over the area where laryngoscopy must be performed, teeth loosened by pyorrhea or trismus complicating exposure are all hazards of technic and can be met only by adequate technical skill.

Pulmonary Complications.—Any one familiar with the technic described will, of course, realize that one of the chief indications for the use of this technic is the prevention of postoperative pulmonary complications.

Needless Instrumentation.—There is a natural resistance to the use of any technic involving instrumentation of parts when the same or apparently the same result can be secured without such instrumentation. An anesthetist who begins the use of intratracheal anesthesia will himself experience this resistance and will meet it continually when the technic is being introduced to a new surgical team. This difficulty, however, can be overcome only by a conviction of the advantages to be secured by such instrumentation.

Fortunately, this is not a virgin field in this respect. The technic employed rests on the established practice of laryngoscopy and bronchoscopy. To this background has been added the safety conferred by the relaxation of anesthesia and the reduced reflex resistance.

Difficulty of Ordinary Use.—Under the conditions specified, the technic is not more difficult than any other form of instrumentation within a closed cavity. Experience has indicated the need of practice in laryngoscopy in order that the procedure may become secondary to

the specific difficulties which must be met. One must be so familiar with the exposure of the glottis and the manipulation of the intubation tube that one can focus attention on the exceptionally resistant patient, fragile dentures and obstructive infection.

Requirement of Unnecessarily Deep Anesthesia.—A short profound anesthesia does not create as great a hazard as does light anesthesia, complicated by reflex difficulties, aspiration, anoxemia, etc. Deep anesthesia should be secured as a routine for intubation. Following intubation, less anesthesia may be used than is required by any other technic, the reason for this being that spasm of the glottis, cough, vomiting, etc., do not interfere with the control of the anesthetic. One may say that a patient can almost be returned to consciousness and immediately reanesthetized without disturbance of the operative field. No other technic permits so complete a control.

Failure to Prevent Aspiration.—The laryngeal reflex is the most active reflex with which surgeons are familiar. It returns before the pharyngeal and the vomiting reflexes. In the event of vomiting, the glottic reflex is active and the cords are closed tightly about the intratracheal tube. During maintenance, fluid in the pharynx occasionally finds its way into the trachea along the sides of the tracheal tube. This is immediately indicated by bubbling which takes place within the tube. Such fluid may be readily removed by the intratracheal catheter supplied. The intratracheal tube effectively protects the glottis against the aspiration of solid particles, such as teeth, gauze packs and blood clots. Inspection of the mouth and the pharynx before extubation protects the patient from postoperative aspiration. The hypopharyngeal pack provides efficient protection against the aspiration of blood from the mouth. Evidence of this is provided by the consistency of the material removed by the suction catheter. In most cases when the mouth is filled with blood and mucus, the material removed by suction from the trachea shows no staining, proving that the pack was properly placed and that it had not leaked.

Soft Tubes, Such as Rubber, Less Irritating than Metal.—It is the opinion of those experienced in the use of rubber that the contrary is the case. A velvet edge secured by a heavy gage metal tube or a well rounded lip, such as is furnished by the lubricated intratracheal tube, produces a minimum irritation.

Production of Edema of the Glottis.—Edema of the glottis seldom or never follows bronchoscopy not complicated by trauma (no instance of serious traumatic edema has occurred in my experience). Subcutaneous edema from operative trauma is an accident of instrumentation which may occur in any part of the airway from such innocent instruments as the throat suction tube, tongue depressor or retractors.

Obstruction of the Operative Field.—It is granted that the intratracheal tube handicaps the operator who is unaccustomed to its use for operations on the mouth. For this reason, intratracheal anesthesia for tonsillectomy should be reserved for the use of the surgeon who is accustomed to the technic. In all other situations, the tube is unobjectionable.

Failure of Glottis to Close After Extubation, Increasing the Likelihood of Aspiration.—A patient who has been profoundly anesthetized by intratracheal anesthesia for a long period and who has received basal anesthetic medication or medication during the anesthesia will present a sluggish action of the vocal cords on extubation. There is no excuse, however, for permitting this condition to develop. The anesthetist should be aware of the approaching termination of the operation and reduce the anesthetic. The glottis, instead of remaining open on intubation, will habitually grip the intratracheal tube so tightly that it is often difficult to extubate. Extubation should not be attempted in the face of glottic spasm. The patient should be given more anesthesia for a brief period to permit relaxation. Postoperative laryngoscopy in such cases invariably shows a snappy glottic reflex.

CONCLUSIONS

Intratracheal inhalation anesthesia, popularized by Meltzer and Auer more than twenty-five years ago, presents advantages which are as desirable today as when they were introduced. The method fell into disfavor because of the technical difficulties presented by insufflation. The inhalation method developed by me eliminates these difficulties, and while preserving the advantages of the original method has added others. Notable among these is the ability to provide an aseptic field for operation in and about the mouth, freedom from anesthetic vapor in the operative field, facilities for resuscitation without motor-driven apparatus, accommodations for tracheal and bronchial suction during operation, without the intrusion of a catheter into the operative field, and an increase in the age range to include even the youngest infant.

While the apparatus employed is of the utmost simplicity and practically indestructible (light bulbs and Penrose tubes excepted) the utmost care of this equipment is essential to its successful operation. Details of this care and of the technic found satisfactory are reviewed.

Laryngoscopy and intubation under complete relaxation constitute a simple procedure. To provide a field permitting free intubation in every case is not simple. The chief difficulty is to anesthetize the patient.

A safe and satisfactory routine demands the use of ether as an anesthetic. Some anesthetists have forgotten the use of this agent, and others have never learned how to use it.

Intratracheal inhalation anesthesia is specifically indicated in operations on the brain, eye, nose and nasal accessory sinuses, in oral surgery, infections of the airway, harelip and cleft palate, operations about the neck, cosmetic operations on the face, operations on the lungs and in selected abdominal operations.

Its use in tonsillectomy should be limited to those who have accustomed themselves to the presence of a tube in the mouth. For such operations, it provides a fixed and quiet field.

Objections to the method have been raised apparently because of misinformation regarding the background on which the instrumentation rests and the construction of the equipment, a misconception of the nature of the technic and lack of acquaintance with the field provided, the safety afforded and the relative absence of postoperative ill effects.

An experience of ten years in the development and the use of intratracheal inhalation has confirmed the value of the procedure. It has also indicated the incidence of the difficulties to be met and the means of relief.

As a mechanical convenience for reducing mortality and morbidity in operations about the head and neck, there is nothing that can compare with the protection offered by intratracheal anesthesia. Because of its practical value in this field and the increasing tendency of surgeons to accept tracheal manipulation as a matter of course, one need not be surprised to find the technic a routine procedure for general surgical intervention before many years have passed.

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BRONCHIECTASIS IN CHILDREN

WITH SPECIAL REFERENCE TO PREVENTION

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Bronchiectasis has been defined by Dorland [1] as "dilatation of the bronchi or a bronchus." The disease, however, cannot be defined so simply. As J. A. Miller [2] stated: "It is only when such dilatation is accompanied by failure of adequate drainage facilities for the normal secretions and inflammatory exudates that the actual picture of the disease presents itself." Bronchiectasis must be distinguished also from congenital cystic disease of the lungs; in the latter dilatation of the bronchi exists, but the cavities so formed have lost their connections with the tracheobronchial tree. Further, though bronchiectasis may progress to actual formation of a pulmonary abscess, it may also develop as the result of such an abscess. For this reason, it is often difficult to differentiate between the two diseases.

In 1819 Laennec [3] described bronchiectasis for the first time in his book "De l'auscultation médiate." He recounted two cases, one in an adult, the other in a child. A few years later Stokes [4] and Corrigan,[5] of Dublin, theorized on the mechanism by which bronchial dilatation is produced. Corrigan called the condition "cirrhosis of the lung" and explained the dilatation on the basis of pull by contracting scar tissue. Since that time there have been innumerable arguments and theories relative to the etiology and the mechanism leading to bronchiectasis.

Before the advent of direct examination of the trachea and bronchi by means of the bronchoscope, there was a period of almost no progress

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The cases reported are from the Bronchoscopic Clinics of D. Gabriel Tucker at the University and Graduate Hospitals of the University of Pennsylvania.

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1. Dorland, W. A. Newman: The American Illustrated Medical Dictionary, ed. 14, Philadelphia, W. B. Saunders Company, 1927.

2. Miller, J. A.: The Pathogenesis of Bronchiectasis, J. Thoracic Surg. **3**: 246-269 (Feb.) 1934.

3. Laennec, R. T. H.: De l'auscultation médiate, ed. 1, Paris, J. A. Brosson & J. S. Chaudé, 1819, p. 124.

4. Stokes, William: A Treatise on the Diagnosis and Treatment of Diseases of the Chest, Dublin, Hodges & Smith, 1839, pp. 148-171.

5. Corrigan, D.: Cirrhosis of the Lung, Dublin M. J. **13**:270-276, 1838.

in the study of the disease. Direct examination, together with roentgen study after the injection of iodized oil into the tracheobronchial tree, as advocated by Sicard and Forestier [6] and by Armand-Delille,[7] has given new impetus to the study of bronchiectasis.

ETIOLOGY

The enormous variety of ills, held by different authors to be the forerunner or the cause of bronchiectasis, would lead one to conclude that no specific etiologic factor exists. Since, however, all observers agree that in the great majority of these cases the condition has had its inception in the early years, it is among the congenital factors and the childhood illnesses that one should seek the cause.

Many have held that bronchiectasis may be congenital, and Reitter [8] has cited a case which he places in this category. J. A. Miller [2] expressed the belief that developmental factors play a large part in the pathogenesis of bronchial dilatation. He stated that antenatal and postnatal factors may disturb the normal course of differentiation of the lung, which is usually completed about the seventh year of life. In the postnatal period, infections and atelectasis may disrupt the normal sequence of development, so that adult lung structure is never attained. Miller enumerated foreign bodies, new growths, aneurysms and enlarged tracheobronchial lymph glands as causes of atelectasis but apparently disregarded the possibility of pulmonary secretions acting as obstructing agents. Whatever the local factor, it establishes a predilection in these same areas for the subsequent development of disease. According to Miller's theories, this susceptibility, accompanied by impaired capacity for removing pulmonary secretions and the effects of repeated infections, completes the picture regarding the origin of bronchiectasis.

In statistical studies bronchiectasis is found to be preceded by bronchopneumonia more often than by any other disease. In such cases the patient usually has had repeated attacks of pneumonia. Findlay and Graham,[9] Thorpe,[10] Smith [11] and others have noted this connection.

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6. Sicard, J. A., and Forestier, J.: The General Method of Roentgen Study by Iodized Oil, Bull. et mém. Soc. méd. d. hôp. de Paris **46**:463-469, 1922.

7. Armand-Delille, P. F.: The Clinical Forms of Dilatation of the Bronchi and Their Diagnosis by Lipiodol X-Ray, Rev. franç. de pediat. **1**:125-157, 1925.

8. Reitter, G. S.: Congenital Bronchiectasis, Radiology **25**:494-497 (Oct.) 1935.

9. Findlay, L., and Graham, S.: Bronchiectasis in Childhood: Its Symptomatology, Course and Cause, Arch. Dis. Childhood **2**:71-96 (April) 1927.

10. Thorpe, E. S., Jr.: Chronic Bronchiectasis in Childhood with Observations on Early Diagnosis, Am. J. M. Sc. **177**:759-767 (June) 1929.

11. Smith, D. T.: Etiology and Early Diagnosis of Bronchiectasis and Lung Abscess, New England J. Med. **199**:862 (Nov. 1) 1928.

They suggested that the damage to the bronchial walls during the course of pneumonia causes a loss of elasticity and that the dilatation is secondary to mechanical forces, such as the increased intrapulmonic pressure exerted during cough and the extrabronchial traction of fibrous tissue.

The relationship of bronchiectasis to infection of the nasal sinuses has been stressed by Mullin,[12] Clerf [13] and others. Clerf commented on the association of disease of the upper respiratory tract with bilateral bronchiectasis. Erb [14] suggested a reversal of the usual idea and offered bronchiectasis as a cause of sinusitis.

Whooping cough, measles and recurring bronchitis seem to be etiologic factors in other cases. In some of these instances, however, it is possible that bronchopneumonia, unrecognized as such, may have complicated the illness.

Foreign bodies have long been recognized as agents capable of producing bronchiectasis. When the normal ventilation and drainage of the lung are blocked, atelectasis follows and secretions accumulate. Bacteria find this an especially favorable environment.

Intrabronchial obstruction from new growths, although not so frequent in children, and pressure on the bronchi from without, as by enlarged tracheobronchial glands, may produce signs, symptoms and results identical with those produced by foreign body.

A factor not sufficiently stressed but tremendously important from the point of view of the bronchoscopist is the feeble cough mechanism in children. The disproportionately small size of the infant larynx hampers the removal of secretions. Tucker [15] has stressed this point. Cough is weak and infrequent; consequently secretion may accumulate and produce obstruction. This is even more apparent in children who have congenital anomalies of the larynx or the epiglottis. As adolescence is approached, the larynx becomes more like that of the adult, and cough becomes more effective.

Anspach [16] has recently reported a series of fifty cases of pulmonary atelectasis in children. These cases were carefully observed clinically, roentgenologically and, if death occurred, at autopsy. At the outset the clinical picture in these cases resembled pneumonia. The acute symptoms

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12. Mullin, W. V.: The Accessory Sinuses as an Etiologic Factor in Bronchiectasis, Ann. Otol., Rhin. & Laryng. **30**:683, 1921.

13. Clerf, L. H.: The Interrelationship of Sinus Disease and Bronchiectasis with Special Reference to Prognosis, Laryngoscope **44**:568-571 (July) 1934.

14. Erb, I. H.: Pathology of Bronchiectasis, Arch. Path. **15**:357-386 (March) 1933.

15. Tucker, G.: The Infant Larynx: Direct Laryngoscopic Observations, J. A. M. A. **99**:1899-1902 (Dec. 3) 1932.

16. Anspach, W. E.: Atelectasis and Bronchiectasis: Fifty Cases, Am. J. Dis. Child. **47**:1011-1050 (May) 1934.

subsided in a few days, however, and the temperature returned to a nearly normal level. Cough persisted. Roentgenologic examination revealed a triangular area of density at the base of one or both lungs. The density of these areas resembled that of fluid. This fact seems well explained when one remembers that such an atelectatic area is "drowned" with blocked secretions that are unable to drain. These areas of "fluid-like" density have been interpreted in various ways, often being attributed to mediastinal pleurisy with effusion or to mediastinitis. The tendency of the mediastinal structures to shift to the involved side, however, rules out effusions, which tend to shift the structures to the opposite side. In this series, when reexpansion of the collapsed area was observed to take place, Anspach was unable to demonstrate sub-

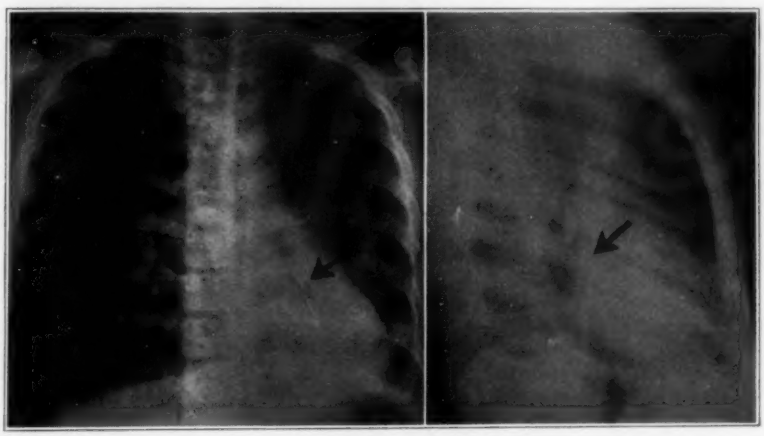

Fig. 1.—A child 10 years of age aspirated a tooth at tonsillectomy three months before admission to the bronchoscopic clinic. Roentgenograms revealed drowning of the lung on the left side, with well developed bronchiectasis in the area of the lung distal to the point of lodgment of the foreign body. After removal of the tooth and repeated aspiration of the secretion, the infection in the lung cleared. At the end of three months the evidence of bronchiectasis had largely disappeared.

sequent development of bronchial dilatation, either clinically or roentgenologically, after the injection of iodized oil. When the collapse was complete and persisted, bronchial dilatation rapidly ensued. In other words, when normal ventilation and drainage of the lung were persistently obstructed, bronchiectasis developed, and when ventilation was quickly reestablished, no permanent damage resulted.

In two of these cases foreign bodies were detected and were removed at bronchoscopy. Bronchoscopic drainage was not mentioned as a therapeutic agent except in the instances of foreign body, in spite of the fact that in the patients who came to postmortem examination the bronchi

and their smaller subdivisions were found to be filled with thick exudate. Postural drainage was used to rid the tracheobronchial tree of secretions.

Proof that secretion may produce definite and complete obstruction of the lungs is abundant. Lee and Tucker,[17] who have published interesting articles on postoperative massive collapse of the lung, have reproduced this collapse in dogs, using secretion removed from patients and also mixtures of acacia of the same viscosity. In adults, the cough mechanism may be inhibited to a marked degree after abdominal operations, owing either to pain or to the sedatives given to allay pain. The postoperative cough mechanism of the adult may be compared to that of the child in its ineffectiveness.

In the opinion of Erb [14] and of McNeil, MacGregor and Alexander,[18] the essential lesion in the production of bronchiectasis is destructive bronchitis, an acute infection with dissolution of the mucosa, submucosa, cartilage and muscle. Frequently the surrounding pulmonary tissues are also involved. McNeil and his co-workers stated: "A bronchiectatic cavity is not a dilated bronchus, but an excavation in the lung substance, starting in a bronchus." Erb expressed agreement with this point of view but stated that there is an additional factor, that of mechanical obstruction. On this basis he explained why in so many cases bronchopneumonia or other violent inflammation of the bronchi resolves while in others it progresses to bronchial dilatation.

From the work of Anspach and of Lee and Tucker on atelectasis and that of Erb on pathology, as well as from my own observations, I draw the conclusion that obstruction, from any of a number of causes, is in the great majority of cases the primary factor in the production of bronchiectasis. This obstruction in turn provides a favorable situation for bacterial growth and action. A violent inflammatory reaction ensues, and in the absence of drainage it extends into the surrounding pulmonary tissue, producing widespread destruction of tissue, or, as McNeil has said, "excavation."

PATHOLOGY

The studies of McNeil, Macgregor and Alexander and of Erb have greatly clarified the pathologic picture of bronchiectasis and the mechanism of its production. These observers have performed autopsies in many such cases on patients who have died of chronic infections or in acute or subacute stages of the disease. The serial picture thus obtained at postmortem examination eliminates the theorizing necessary to those

17. Lee, W. E., and Tucker, G.: Postoperative Pulmonary Atelectasis, Atlantic M. J. **31**:284-293 (Feb.) 1928.

18. McNeil, C.; Macgregor, A. R., and Alexander, W. A.: Studies of Pneumonia in Childhood: Bronchiectasis and Fibrosis of the Lung, Arch. Dis. Childhood **4**:170-189 (Aug.) 1929.

observing only late stages. These men have observed the disease, if not in every minute change, at least at regular intervals in the course of its development.

First, during the acute attack of pneumonia or whatever the initial infection may be there is a violent inflammatory reaction with destruction of tissue. This destruction of tissue extends for variable distances; it may involve part or all of the structures comprising the bronchial wall. Frequently, there is necrosis extending into the surrounding pulmonary tissues, resulting in excavation. The inflammation may be more violent in one area than in another, so that unequal excavation may result. There is cellular infiltration of all the tissues. The smaller bronchi and bronchioles are filled with thick, purulent secretions.

If the patient survives the acute illness, healing begins to take place. Granulation tissues appear; these are vascular, fibrocellular agents of repair. New growths of epithelium commence about the bits of surviving mucosa and gradually spread out to cover the surface of the granulations. Eventually, if complete healing takes place, an entire new bronchial lining is formed. The cells of the new mucosal epithelium are of an altered type, changing from ciliated columnar to squamous or cuboidal. The fibrocellular repair tissues become more dense and contract to form heavy scar tissue.

The affected area of lung, then, is shrunken and firm in the completely healed state. It contains dilated or "excavated" bronchi, which are lined by an abnormal and functionally poor type of epithelium. There are few or no functional air spaces or alveoli, because these are compressed or obliterated by the contracting scar tissue everywhere present. The dilatation of the bronchi, due to the original destructive infection, may also be further increased by the pull of the gradually contracting scar tissue.

DIAGNOSIS

History.—The first step in the diagnosis of bronchiectasis is a careful investigation of the history. Usually some serious pulmonary incident of early childhood has preceded the development of bronchial dilatation; more rarely, the onset has been insidious.

The patient's most frequent cause of complaint is a chronic cough. Most children, even the older ones, tend to swallow rather than to expectorate the secretions, so that a history of expectoration is not obtained. The quantity of secretion produced varies greatly, being influenced by intercurrent acute infections, especially of the respiratory tract.

Hemoptysis is another frequent source of complaint, often causing an erroneous diagnosis of pulmonary tuberculosis. Vascular granulations, which are a part of the repair process, are usually the source of

the bleeding. As a rule the hemorrhage is slight, merely tingeing the sputum; occasionally the bleeding may be alarming or even fatal.

Easy fatigue, loss of appetite and failure to gain weight may be noticed by the patient. Night sweats are not infrequent in children having bronchiectasis. Shortness of breath and cyanosis are usually noted only late in the course of the disease.

Physical Examination.—Physical examination is, as a rule, not reliable. The extent of the damage as revealed by physical signs is often in marked variance to the roentgen and bronchoscopic findings. The general state of health is surprisingly good in many instances; there is usually a moderate underdevelopment in both weight and height. Examination of the chest may reveal nothing. More frequently, some signs of a basal lesion are present. They vary from evidences of fibrosis or consolidation to evidences of cavitation. One should not expect frank signs of cavity formation, even after postural drainage, for they are seldom elicited.

Laboratory Findings.—Tubercle bacilli are absent from the sputum, except in those cases in which bronchiectasis is associated with pulmonary tuberculosis. The reaction to tuberculin is usually negative, but a positive reaction is conclusive evidence neither for tuberculosis nor against bronchiectasis. In most cases the bacteriologic culture of the secretion reveals a number of different organisms, none of which are specific. Streptococcus, Staphylococcus, Pneumococcus, Micrococcus catarrhalis and Bacillus influenzae are among the more frequent. Anemia of the secondary type with mild leukocytosis is often present.

Roentgen Studies.—Marked thickening of the peribronchial tissues of the lower lobes is one of the most significant roentgen findings. Areas of atelectasis and pneumonitis, as well as abscess formation, which is often multiple, may be noted in association with bronchiectasis.

Although roentgen examination after the injection of iodized oil into the tracheobronchial tree clearly delineates the location and extent of bronchial dilatation, the use of this method of examination should not be indiscriminate. It must be remembered that instances of fatal iodism have been reported. This procedure should be reserved for those cases in which a doubt still persists after bronchoscopic examination has been made, as in early stages, or in those instances in which surgical removal of the affected tissues is contemplated, and it is imperative completely to "map out" the dilated bronchi.

Bronchoscopic Examination.—No diagnosis of bronchiectasis should be considered complete until a direct examination of the tracheobronchial tree has been made by a competent bronchoscopist. However, this examination should be deferred until all other necessary studies have been completed. A well trained bronchoscopic team can make such an

examination, even in children, without the use of a general anesthetic. The hazard of irritation to the lungs is thus eliminated. The only necessary preparation of the patient is the withholding of food and fluid for five hours prior to diagnostic bronchoscopy, although a hypodermic injection of morphine sulfate in dosage suitable to the weight and age of the child may be given an hour beforehand.

The findings at bronchoscopic examination vary greatly with the severity of the dilatation and the degree of suppuration. In most cases, stagnant pus is encountered as the tube enters the trachea. The secretion may be collected without contamination for bacteriologic study. When the divisions in the lower lobe are reached, pus may be seen to exude from the affected bronchi with each cough. The degree of dilatation may be estimated by direct inspection. Granulation tissue may be present in the bronchi, often occurring in sufficient quantity to act as an agent of obstruction. After the tracheobronchial tree has been completely aspirated, iodized oil may be injected under vision into any area in which involvement is suspected. By this method a much smaller quantity of the solution is sufficient for a complete delineation and unfavorable reaction from the iodine may be avoided.

TREATMENT

Prevention.—It is my contention that bronchiectasis is frequently preventable. In many cases the underlying factor is mechanical obstruction. The removal of this obstruction, when possible, is definitely indicated. This treatment, accompanied by competent pediatric supervision and close cooperation from the roentgenologist and the otolaryngologist, will assist greatly in eliminating the disease. Properly speaking, these cases do not come under the exclusive supervision of a specialist in any one field but require the concerted efforts of all.

E. S. Thorpe [10] has stated: "If all cases suspected of having suppurative bronchitis were bronchoscopically treated, and not filled with worthless cough mixtures, bronchiectasis would actually be a rarity." In this statement Thorpe laid stress on the important rule governing the treatment of all infection, namely, that it is necessary to promote drainage, not to impede it. All too frequently a child is "loaded up" with sedative intended to allay an annoying, persistent cough. Because of his small larynx, the child has a difficult time at best in the elimination of secretions. During the course of respiratory infection, he needs aid, certainly not the handicap of cough sedatives. The normal expulsive mechanisms, including cough, bronchial movements and ciliary action, should be supplemented by bronchoscopic aspiration. Autogenous vaccine prepared from the secretion removed at bronchoscopic treatment has in my experience given excellent results in relieving purulent

tracheobronchitis. The vaccine increased the immunity to reinfection. It should be administered under the direction of the pediatrician, who should also direct the medical treatment concerning the general bodily health. The otolaryngologist must combat infections in the upper respiratory tract, thus reducing the frequency and severity of reinfection. When all these measures have been carefully carried out, good results are obtained.

Chronic cough should be considered an indication for bronchoscopy if pulmonary tuberculosis and focal irritation in the ear, nose and throat are ruled out. When the temperature remains somewhat elevated and cough persists after an acute infection of the respiratory tract has subsided, the child should be thoroughly examined. Thickening of the peribronchial tissues as disclosed by roentgenograms is suggestive of bronchitis or bronchiectasis. Children who have had repeated pulmonary infections are especially prone to suffer residual damage of the tracheobronchial structures and for this reason require special care and attention.

In many instances bronchiectasis develops in the course of or shortly after acute infectious illnesses of childhood. The early recognition of unusual pulmonary complications, their correct diagnosis and prompt treatment are essential to prevention. How frequently is the so-called complicating pneumonia actually an area of atelectasis? The diagnosis of bronchopneumonia in infants is often based on somewhat nebulous findings. A few scattered râles, an area of suppression of breath sounds, often the clinical chart alone, may form the basis for diagnosis. In the face of potentially serious results, an accurate determination of the nature of the lesion must be made. Closer cooperation with the roentgenologist would greatly aid the pediatrician in the forming of such a diagnosis.

Pulmonary atelectasis must not be treated in an expectant manner. Atelectasis is definite evidence of pulmonary obstruction. No one questions the fact that bronchiectasis may follow prolonged obstruction from foreign bodies, and the value of their bronchoscopic removal has long been recognized. Foreign bodies, however, do not have a unique effect in this regard; obstruction from any cause may produce the same result and demands, therefore, the same prompt eradication.

Treatment.—Once bronchial dilatation has become established in a well marked form, surgical extirpation of the diseased tissues is the only treatment capable of producing a cure. In the early stages, in which bronchial dilatation is slight, other forms of treatment may effect an actual disappearance of the dilatation. This disappearance takes place in growing children because in normal development the tracheobronchial tree rapidly changes its caliber and "catches up" therefore to the dilated

area, provided the damage done was slight and shows no tendency to increase. Failure to make an early diagnosis and to subject the patient to the proper treatment prevents this ideal result from being realized more frequently.

Surgical extirpation of portions of the lung is a serious operation and should be undertaken only after the combined efforts of the bronchoscopist, otolaryngologist and pediatrician have failed to produce a cure, or at least an amelioration so marked as to make surgical intervention undesirable. As surgical technic improves, making the procedures in lobectomy and in pneumonectomy increasingly safe, the number of cases in which such intervention is undesirable will correspondingly decrease. Although J. S. Bohrer [19] reported a series of four cases without death, recent statistics show that the immediate mortality rate for lobectomy, even for the most skilled operators, is

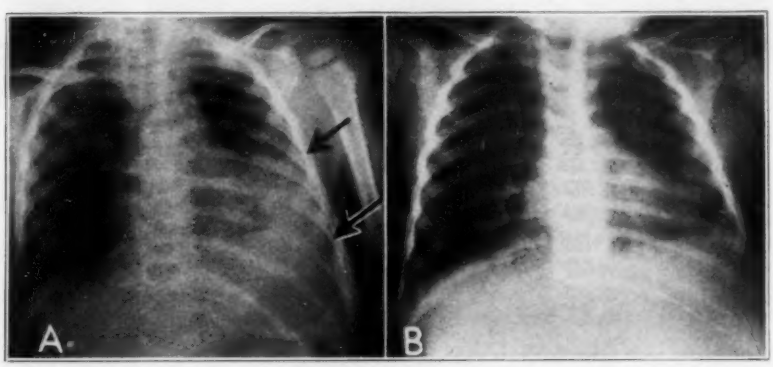

Fig. 2.—A child 2½ years of age acquired an acute infection of the upper respiratory tract, with resultant acute mastoiditis which required operation. After mastoidectomy the temperature remained elevated although the wound was clean. Roentgen examination of the chest showed a drowned area in the lower lobe of the left lung (*A*). Bronchoscopy was performed, and a considerable amount of obstructive secretion was removed from the left lung. The lung cleared after one bronchoscopic aspiration, the temperature came to normal and the child had an uninterrupted recovery. This type of lesion in a small child frequently results in bronchiectasis when the secretions are not removed. A timely bronchoscopic aspiration of the fluids from the lung in this instance prevented bronchiectasis.

about 10 per cent. For pneumonectomy the figure is even higher. For this reason, many patients whose condition is suitable for operation and who will never be completely cured in any other way prefer to "go along" as best they can with the aid of bronchoscopic drainage and the help obtained from the pediatrician and the otolaryngologist. Many

19. Bohrer, J. V.: Lobectomy for Bronchiectasis: Report of Four Cases in Children, Ann. Surg. **102**:1076-1078 (Dec.) 1935.

other patients are unsuited for surgical procedures because of the extent and location of the lesions. Patients with bilateral bronchiectasis are usually considered as unsuitable for surgical treatment. The only treatment for such patients lies in making them as comfortable as possible.

The palliative treatment of bronchiectasis includes careful attention to general health and to foci of infection in the upper respiratory tract, as mentioned under prevention. Periodic bronchoscopic aspiration of pulmonary secretions must be carried out in addition to regular postural drainage. Jackson [20] and Tucker [21] have commented on the efficacy of bronchoscopic aspiration in the treatment of bronchiectasis. The frequency of bronchoscopic drainage varies with the individual case. At first it may be necessary as often as twice a week. This frequency

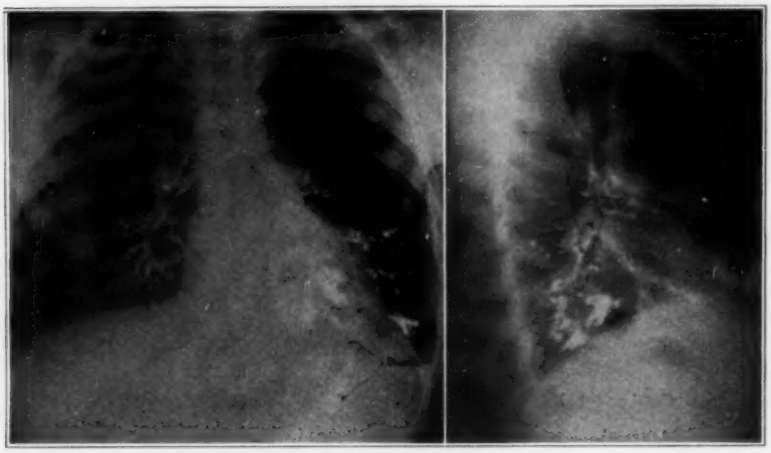

Fig. 3.—A boy 10 years old had had repeated attacks of acute tracheobronchial infection, with persistent cough and physical signs of bronchiectasis in the left lung. Instillation of iodized poppy-seed oil showed markedly dilated bronchi in both the anterior and the posterior films in the area of the lower lobe of the left lung. Instillation in the right lung outlined a normal bronchial tree. Repeated bronchoscopic aspiration in cases of this type frequently results in cure and always results in marked improvement of the pulmonary condition.

is possible because bronchoscopic treatment may be performed by a well trained unit without the use of a general anesthetic. Later, after the pulmonary suppuration has lessened and the general resistance to reinfection has increased, less frequent aspiration will suffice to maintain free pulmonary drainage. Treatment once a month or even once in six

20. Jackson, C., and Jackson, C. L.: Bronchoscopial Observations on Postoperative Pulmonary Complications, Ann. Surg. **98**:516-527 (April) 1933.

21. Tucker, G.: Bronchoscopy in Pulmonary Disease, Ann. Int. Med. **8**:444-458 (Oct.) 1934.

months may be all that is required. So long as free pulmonary drainage of the suppurative secretions is maintained, the child will remain free from all systemic symptoms. If obstruction to drainage is permitted to occur, systemic signs and increased local damage will result. Moore and Love [22] recommended the use of a solution of bacteriophage and injected this directly into the affected bronchi after they had been cleared of secretion by aspiration. They reported good results.

When all the measures that have been mentioned are carried out, the patient can expect marked amelioration of his symptoms. Moderate physical activity is usually well tolerated. The general health is good, and there is little or no tendency for progression of the local pulmonary damage.

CONCLUSIONS

Mechanical obstruction is one of the most important factors in the production of bronchiectasis.

Since in many cases bronchiectasis originates during or shortly after the acute infectious illnesses of childhood, special watchfulness is necessary when signs of pulmonary lesions are present.

Bronchoscopic examination, as an aid in diagnosis, is indicated for children with chronic cough or for those who have repeated pulmonary infections, provided pulmonary tuberculosis has been ruled out.

In many instances, bronchiectasis could be prevented by removing the source of mechanical obstruction, thus aiding aeration and drainage of the lung.

Bronchoscopic aspiration is an effective means of providing and maintaining free pulmonary drainage. When such aspiration is combined with suitable general measures and appropriate care of the nose and throat, the early stages of bronchiectasis may be cured, while in the late stages many patients may be so improved as to lead normal lives if they are somewhat careful.

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22. Moore, W. F., and Love, J. W.: Preliminary Report on Clinical Application of Polyvalent Staphylococcus Bacteriophage, Am. J. M. Sc. **189**:91-95 (Jan.) 1935.

NASAL OBSTRUCTION IN THE ADULT

A QUANTITATIVE STUDY

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While the physician is frequently called on to treat nasal obstruction, the routine procedure has been to determine the amount of obstruction and the result of treatment entirely by empirical methods. Various observers[1] have recognized the need of a quantitative basis for the study of nasal obstruction and have sought to measure the resistance to air flow through the nasal passages during inspiration and expiration with the patient breathing at different rates. However, the methods employed failed to eliminate the variable elements introduced by the subject. The procedures were time consuming and did not attain widespread clinical use. The present study, therefore, was undertaken to measure nasal obstruction by gaging the resistance encountered by air drawn through the nasal chamber, independent of nasal breathing. For this purpose a simple apparatus and a practical office procedure were devised.[2] The present paper is concerned with a description of the method of study, certain anatomic and physiologic considerations, the experimental data and the results obtained.

METHOD OF STUDY

The apparatus (fig. 1) employed throughout the study consists of a nosepiece connected by means of a Y tube with an inclined manometer containing a desirable fluid (gage *E*) and a standard air flowmeter attached to a suitable source of suction. A safety-bottle is interposed in the line of suction to prevent fluid from being unexpectedly drawn up into the nose.

The procedure was simply to advise the subject to breathe slowly through the mouth with the nosepiece applied, as illustrated in figure 1 *F*. To prevent swallowing during the test, the subject's tongue was held by the examiner. Air was

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From the Nose and Throat Department of the Beth Israel Hospital.

1. (*a*) Zwaardemaker, H.: Physiologie der Nase und ihrer Nebenhöhlen, in Denker, A., and Kahler, O.: Handbuch der Hals-Nasen-Ohren-Heilkunde, Berlin, Julius Springer, 1925, vol. 1, pp. 439-444. (*b*) Undritz, W.: The Rhinoamemometer, Acta oto-laryng. **14**:513, 1930. (*c*) O'Malley, J. F.: Ventilation of the Nose and Accessory Sinuses, J. Laryng. & Otol. **48**:309 (May) 1933. (*d*) Krimsky, E. E.: Dynamics of Nasal Respiration, Arch. Otolaryng. **16**: 705 (Nov.) 1932.

2. Sternstein, H. J., and Schur, M. O.: Quantitative Study of Nasal Obstruction: A New Method, Arch. Otolaryng. **23**:475 (April) 1936.

drawn through the nasal airway at a rate varying from 1.5 liters per minute to 14.4 liters per minute, and the resistance encountered was read from the draft gage, scale H.

A 0.5 per cent aqueous solution of cocaine hydrochloride was used to shrink the nasal passages. Measurements of resistance were repeated at frequent intervals. Corrections were made for the diameters of the various nosepieces used.

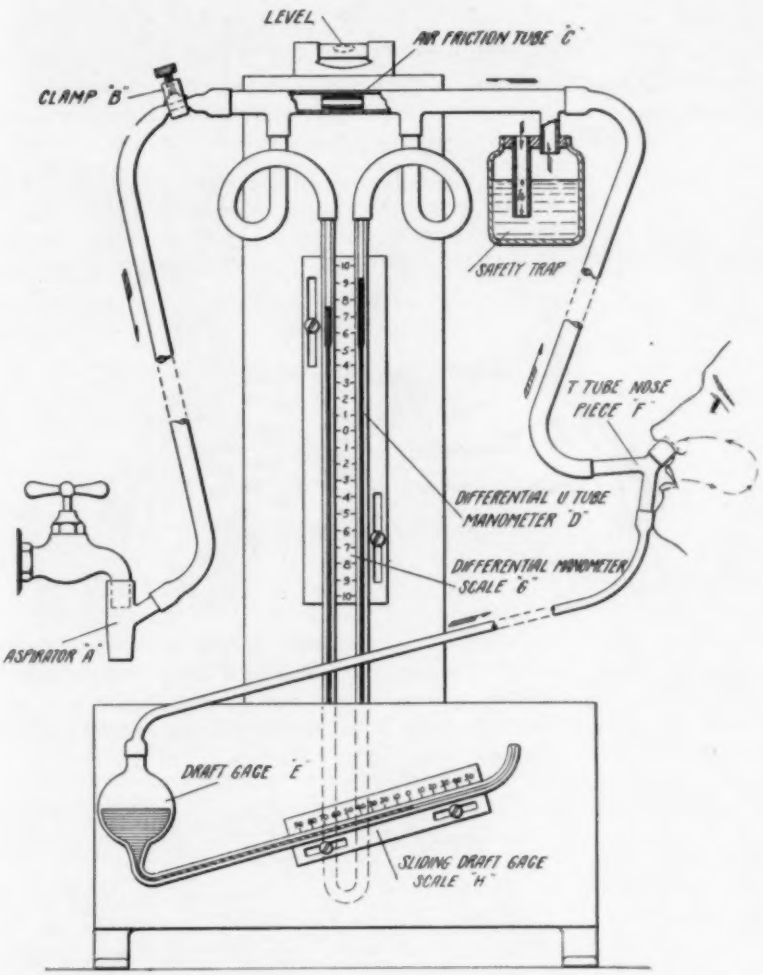

Fig. 1.—The apparatus employed to gage air flow resistance in the nasal airway. Note the direction of air flow as indicated by the arrows.

ANATOMIC AND PHYSIOLOGIC CONSIDERATIONS

The nasal airway as distinguished from the skeletal structure of the nasal chamber represents an arched pathway that extends from the

anterior nares to the posterior choanae. It is bounded laterally and above by the under-surface and the anterior tip of the middle turbinate, below by the upper and the outer middle surface of the inferior turbinate, and medially by the septum [3] (fig. 2).

Schaeffer [4] observed from the measurements of a large series of skulls that various factors, such as (1) the type of nose, (2) the degree of arching of the hard palate, (3) the configuration of the turbinates and (4) the size, shape and disposition of the sinuses, affect the patency of the nasal tract and constitute the underlying anatomic causes of faulty nasal breathing.

MATERIAL

The subjects chosen were divided into normal and abnormal groups, and data tabulated concerning age, sex, weight, number of experiments, chief complaints, clinical findings and clinical and roentgen diagnosis. The normal group were those without blockage or disease of the nasal tract. The abnormal group were those

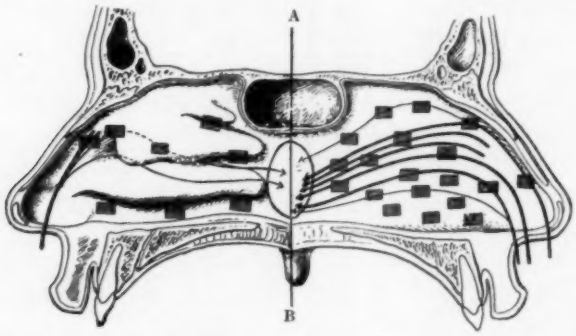

Fig. 2.—A longitudinal section of the nasal chamber laid open, showing the pathways of the respiratory air currents. The dark heavy lines indicate the direction of the major air currents along the septum. The lighter lines show the minor air currents in the vicinity of the turbinates. *AB* indicates the perpendicular axis and *C* the right choana. (After Paulsen.)

with blockage or disease of the nasal tract. Nasal obstruction was classified as partial or complete, and these classes were subdivided into unilateral, alternating and bilateral types.

The thirty-two subjects selected for this study, twenty-one females and eleven males, ranged from 16 to 69 years of age. The normal, or control, group numbered ten subjects: nine females and one male. The anatomic findings considered as normal in this group were tabulated as nonobstructive septal deviations and spurs. In one patient, a woman 60 years of age, a huge conchal cell [5] had developed in the anterior tip of the middle turbinate and occupied approximately two thirds of the anterior nasal chamber (fig. 3). While this cellular anomaly

3. Zwaardemaker,[1a] pp. 443-444.

4. Schaeffer, J. P.: The Nose and Olfactory Organ, Philadelphia, P. Blakiston's Son & Co., 1920, p. 72.

5. Schaeffer,[4] pp. 221-226.

appeared surgically obstructive, the patient, except for a mild postnasal drip, complained of no difficulty in nasal breathing, and tests with the apparatus showed no interference with the nasal air flow. Roentgenograms of the sinuses taken before operation showed no pathologic changes, and microscopic examination of the subsequently removed structure gave negative results. There were no changes in the readings for resistance postoperatively, despite the apparent increase in the roominess of the nasal chamber.

The abnormal group comprised twenty-two subjects: twelve females and ten males. Of this group, all but three complained of either intermittent or constant blockage extending from a few months to a maximum interval of twenty-five years. Although the remaining three gave no history of blockage, the clinical findings pointed to disease of the nasal tract. Of those who complained of blockage, the obstruction in six was alternating, in eight it was unilateral and in five bilateral. Of the six with alternating blockage, three showed deviations of the septum to the left associated with hypertrophic and in one case with chronic degenerative changes of the nasal mucous membrane, two showed deviations of the septum to the right, with allergic nasal mucous membranes, and one showed bilateral hypertrophy of the inferior turbinate. Of the eight patients with unilateral blockage, one showed a spur of the left side of the septum with edema of the left inferior turbinate, four showed deviations of the septum to the right, with hypertrophied

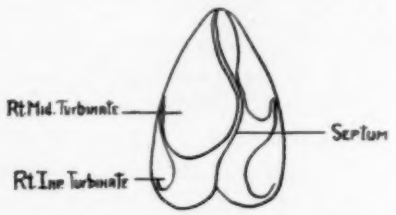

Fig. 3.—Schematic drawing to illustrate the overdeveloped conchal cell in the right middle turbinate as seen through the nasal vestibule. Note that the septum is pushed outward laterally and the inferior turbinate flattened and thinned out to accommodate the growth and allow for adequate breathing space.

nasal mucosa in three, one hyperthrophy of the posterior tip of the right inferior turbinate, one a hypertrophy of the right inferior turbinate and one an atrophic mucous membrane. Of the five patients with bilateral blockage, one showed bilateral hypertrophy of the inferior turbinates, one an S-shaped septum with hyperplasia of the anterior tip of the left middle turbinate, one hypertrophy of the left inferior turbinate, one hypertrophy of the posterior tips of both inferior turbinates and one an atrophic nasal mucous membrane. Of the three patients with no blockage, one showed a spur on the left side of the septum and a polyp of the right superior meatus, one a spur on the right side of the septum with chronic hypertrophy of the nasal mucous membrane and one an atrophic mucous membrane. A correlation of the clinical findings and the type of blockage showed no particular relationship.

The clinical diagnoses made in the group with pathologic nasal tracts were as follows: One had chronic degenerative polypoid sinusitis, five chronic hypertrophic catarrhal rhinitis, one chronic polypoid ethmoiditis (right), one chronic hyperplastic ethmoiditis (left), two chronic hypertrophy of the right inferior turbinate, three atrophic rhinitis, one subacute hypertrophic catarrhal rhinitis, two chronic hyperplastic pansinusitis, one chronic right maxillary sinusitis of prob-

able allergic origin, two chronic hyperplastic sinusitis (allergic), one allergic rhinitis, one obstructive deviation of the septum and one acute hypertrophic catarrhal rhinitis.

Roentgenograms of the sinuses were taken only in eleven cases and showed corroborative evidence of disease.

RESULTS

Of the series of one hundred and forty experiments which forms the basis of this report, seventy were conducted before shrinkage of the nasal mucosa and seventy after shrinkage. Of the seventy experiments

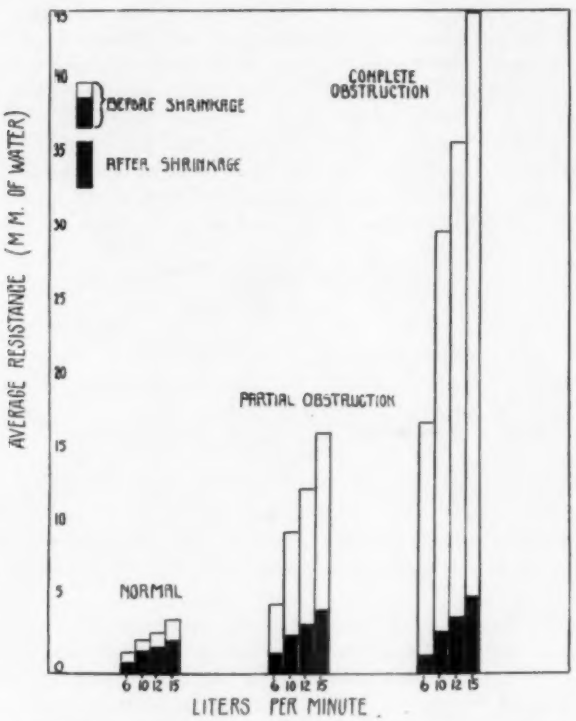

Fig. 4.—A comparison of the average resistance measurements for the normal, partially obstructed and completely obstructed nose, before and after shrinkage. The reading before shrinkage is represented by the total height of the black and white column. The reading after shrinkage is represented by the height of the black column.

completed before shrinkage, twelve were control and fifty-eight were made on the abnormal group. In the former, resistance measurements were generally low; in fifty-three of the latter (91.3 per cent) they were typically high, while in the remaining five (8.7 per cent) they were low. In three of these five, the clinical diagnosis was atrophic rhinitis, in one chronic catarrhal rhinitis and in one a small polyp in the olfactory

sulcus. In the seventy experiments conducted after shrinkage, the twelve normal and the forty-eight abnormal (82.7 per cent) noses gave approximately the same low readings, while the readings for the remaining ten (17.3 per cent) were regarded as high. In figure 4 is shown a comparison of the average resistance measurements in the normal and in the partial and the completely obstructed nose. The total white and black columns indicate the readings before shrinkage and the black after shrinkage. A numerical index of the shrinkage capacity was obtained by dividing the total resistance before shrinkage by the resistance after shrinkage.

A striking increase of resistance to air flow was observed as the nasal blockage changed from the partial to complete. The readings after shrinkage, however, presented a slight difference as compared with the normal. In the normal nose, the index, or amount, of shrinkage was found to be 35 per cent, in the partially obstructed nose 75 per cent and in the completely obstructed nose 90 per cent.

COMMENT

The mechanical behavior of the respiratory air flow through the nose is governed by the same physical laws that apply to the passage of fluids through any constricted area. Within experimental limits it was found that air flow resistance curves [6] for the nasal airway were similar to those of any orifice type of flowmeter (fig. 2). The range of air flows used for each nasal chamber, namely, from 6 to 15 liters per minute, compared favorably with a similar increase in the inspiratory or expiratory phases of physiologic respiration following greater activity. It was observed, however, that the subject was unable to tolerate for more than a few moments, nasal air flows beyond 15 liters per minute passing in a single direction. The values for resistance obtained within the limits of air flow described, nevertheless, clearly demonstrated the amount of functional air space available for nasal respiration. No evidence was found to support the general belief that accurate information concerning the amount of nasal obstruction can be gathered from the gross structural findings. This was especially noteworthy in the case of the enlarged conchal cell (fig. 3) in which, unexpectedly, atrophic rhinitis developed soon after operation. In its scope of application, the present method offers a valuable adjunct in the diagnosis and treatment of nasal obstruction. From a medicolegal standpoint it suggests a

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The general equation for the flow of fluids through a constricted area, such as the nasal airway, is on the general formula $v2 = 2\ gh$, in which v is the velocity, g the constant of gravitation and h the head or pressure. Such an equation can be plotted as a straight line on ordinary coordinate paper if the logarithms of the numbers are used as coordinates. However, it was simpler to plot the actual arithmetical values on double logarithmic paper as straight lines. (Drinker, P.: Personal communication to the author.)

means whereby absolute evidence can be established to prove malingering or neurosis. In the field of industrial hygiene [7] the method is to be employed on an experimental basis for determining which men are best fitted for dusty jobs, as in the granite, sand-blasting and mining industries, in which silicosis is a constant menace.

SUMMARY

Thirty-two subjects were studied in a series of one hundred and forty experiments to determine how much resistance air encounters in its passage through the nasal airways independently of voluntary nasal breathing. A special apparatus and simple technic were employed. The subjects were divided into groups with normal and abnormal nasal airways. The normal group consisted of those without blockage or disease of the nasal tract. The abnormal group were those with blockage or disease of the nasal tract. It was observed that the clinical findings bore no definite relationship to the type of blockage present.

Within experimental limits it was found that air flow resistance curves of the nasal airway were similar to those obtained with any orifice type of flowmeter.

In the normal airway resistance measurements were found to be characteristically low and could be plotted within a typical zone. The percentage of shrinkage capacity was determined from the resistance readings before and after shrinkage and gave a specific index of 35 per cent. The resistance curves clearly demonstrated the patency of the nasal airways.

In the abnormal airway resistance readings were found to be characteristically high and could be plotted in particular zones for partial and complete nasal obstruction. Partial nasal obstruction gave a numerical index of 75 per cent, while complete nasal obstruction showed an index of 90 per cent. The resistance measurements clearly presented a visual record of the amount of obstruction encountered in the nasal chamber.

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7. Tourangeau, F. J., and Drinker, P.: The Dust Filtering Efficiency of the Human Nose, to be published.

ABERRANT GOITER

WITH REPORT OF AN INSTANCE OF INTRALARYNGEAL THYROID TUMOR

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Aberrant goiter may be defined as a thyroid tumor in a location other than that usually occupied by the normal thyroid gland. There are two types, true and false. If the aberrant tissue remains attached to the normally placed thyroid gland and appears to be an outgrowth from it, the term false aberrant goiter may be used to describe it. But if no connection can be traced between the aberrant goiter mass and the normal thyroid gland, or if the latter is entirely lacking, the tumor is properly classed as a true aberrant goiter.

Probably true aberrant goiter develops only from thyroid tissue which has been deposited in the embryo in the development and descent of the thyroid gland. Such a deposit may occur at any point along the course of descent from the foramen caecum to the normal site of the gland or beyond it. It occasionally occurs in odd locations away from the midline, such as the posterior triangle of the neck, the supraclavicular region and the nasopharynx. Since these regions are remote from the normal tract of embryonal descent, the presence of thyroid tissue in one of them is hard to fit in completely with the current conception of tissue rests along the embryonal tract.

Embryologists seem inclined to believe that the thyroid gland originates solely in the median primordium. Between the third and the eighth week of fetal life the primordium of the thyroid gland grows downward from the foramen caecum to its normal position in the neck, where it becomes bilobed, forming the isthmus and the lateral lobes of the thyroid gland. Then the stalk becomes obliterated.

Some years ago C. H. Mayo [1] advanced the theory that the normal descent of the gland may become obstructed by too early development of the hyoid bone and the gland may thus be diverted into the lingual or sublingual region. While it is true that the largest number of aberrant thyroid tumors are situated between the base of the tongue and the hyoid bone, this theory leaves unexplained those which occur within the larynx or the nasopharynx or away from the midline in the neck.

Read before the Milwaukee Oto-Ophthalmic Society, Oct. 13, 1936.

1. Mayo, C. H.: Lingual, Sublingual and Other Forms of Aberrant Thyroids, J. A. M. A. **57**:784 (Sept. 2) 1911.

The commonest location of aberrant goiter is at the foramen caecum, where its occurrence has been reported about 250 times. In other locations it is observed much less often. There is no doubt that the incidence of aberrant goiter is much greater than statistics would indicate. The anomaly by no means always produces clinical symptoms except when it is so situated that it causes mechanical obstruction or pressure; thus it becomes easy for it to escape the notice of clinicians and pathologists. Even when it produces symptoms it is sometimes overlooked. It is remarkable that so many persons with intralaryngeal tumor are treated over long periods for asthma before diagnosis of intralaryngeal tumor is made. One must inevitably conclude that if these "asthmatic" patients can attain ages of from 30 to 50 years without any one taking the trouble to look within the larynx, it is probable that others under similar circumstances may never be so examined and that some intralaryngeal tumors are thus entirely missed.

The symptoms of true aberrant goiter are often trivial or absent. About five years before the time of writing I removed an aberrant thyroid tumor of the lingual type occurring in a girl 9 years old. This tumor was round and about 3 cm. in diameter. It appeared on inspection to occupy a considerable space in the oropharynx, but it had caused no clinical symptoms except a mild disturbance in swallowing. Islands of thyroid tissue in other locations in the neck can go along for many years without producing serious trouble. In this connection, when the removal of an aberrant thyroid tumor is contemplated, it is well to determine positively whether there is also a thyroid gland present in the normal location, as the aberrant tissue may be all the patient has.

Granted that aberrant goiter in any location is rather uncommon, it is certain that intralaryngeal goiter is a condition of extreme rarity. Search of the literature for statistics on the occurrence of intralaryngeal goiter shows little mention of the tumor and a dearth of case reports. Cunning [2] mentioned the following types of benign tumor of the larynx in the order of their frequency: "papilloma, polyp, vocal nodules, contact ulcers, fibroma, cystoma, lipoma, adenoma, chondroma, varices, mycosis fungoides and thyroid tumors." He then went on to say: "A large proportion of these are so rare as to be unworthy of serious discussion, as for example, the thyroid tumors of the larynx mentioned by Jackson, who in his large experience has seen only eleven cases."

Babcock,[3] reviewing a series of 541 cases of benign intralaryngeal tumor from the service of Coakley at the Presbyterian Hospital, in New

2. Cunning, D. S.: Benign Tumors of the Larynx, New York State J. Med. **34**:56 (Jan. 15) 1934.

3. Babcock, J. W.: Tumors of the Larynx, S. Clin. North America **14**:301 (April) 1934.

York, found no instances of thyroid tumor. Dr. Gordon B. New, in a recent personal communication, stated that no intralaryngeal thyroid tumors have been noted at the Mayo Clinic over several years.

Jackson [4] stated that the tumor is "rare in the larynx; less rare in the trachea." Of the eleven growths he mentioned as having come under his observation, one "was connected through the tracheal wall with a goiter externally" and would classify as a false aberrant goiter; two were malignant. Chevalier L. Jackson, in a recent personal communication, cited three additional cases described in a book on the larynx [5] which will appear in the near future. The patients were two men, aged 42 and 34, respectively, and one woman, aged 38. They presented the common history of previous treatment for asthma. There had been no recurrence when these persons were examined five, four and two years later, respectively.

REPORT OF A CASE

A man 51 years of age had worked hard on a farm all his life. He had been in good health until the summer of 1935. He had had no operation, accidents or rheumatism. He had been a heavy smoker and a fairly hard drinker. The family history showed nothing of significance. His mother attained the age of 84, and the father died at 36 of some condition which was not diagnosed but which produced jaundice.

Although he had noted progressive hoarseness and increasing difficulty in breathing for four years, he paid little heed to them until July 1935, when he had what his daughter described as a severe "choking spell." At that time a physician was called to the farm home in the night, made a tentative diagnosis of asthma and gave a hypodermic injection of a preparation, which was perhaps epinephrine. Throughout July and August the dyspnea continued, being now better, now worse. He lost a considerable amount of weight. Other medical advice was sought in this period, but the physician was always called to his farm home at night, in what was considered an emergency, and it appeared that each time the same diagnosis was arrived at and the same treatment given.

On Sept. 5, 1935, this man staggered into my office in a state of almost complete physical exhaustion. He had a most alarming dyspnea and cyanosis. His lips and skin were of a deeply bluish tinge. He was using all the accessory muscles of respiration. Each breath was accompanied by a harsh gasp. His voice was hoarse and rough and was produced only with tremendous effort.

A hasty examination of the larynx disclosed a suprisingly large tumor almost completely occluding the glottis and extending upward from it. The tumor was smooth, nodular and pale pink. It was attached by a wide base to the right side of the intralaryngeal wall at the level of the right vocal cord. On being grasped with forceps it gave the impression of fibrous hardness. It scarcely

4. Jackson, Chevalier: Benign Tumors of the Larynx, in Jackson, C.; Coates, G. M., and Jackson, C. L.: The Nose, Throat and Ear and Their Diseases, Philadelphia, W. B. Saunders Company, 1929.

5. Jackson, Chevalier, and Jackson, Chevalier L.: The Larynx and Its Diseases, Philadelphia, W. B. Saunders Company, to be published.

could be moved in any direction. A small pledget of cotton on a laryngeal applicator could be passed along the left side of the mass, but only with the greatest difficulty could air be passed through this narrow chink. An effort to increase temporarily the size of the airway by shrinking the tumor and adjacent tissues with cocaine and epinephrine was without much avail, but it did serve to tide him over the period of his removal to the hospital. While doing the tracheotomy I noted that the thyroid isthmus was both wide and thick. It was divided to facilitate the handling of the tube. The patient did well after the tracheotomy. A roentgenogram of the neck made soon afterward (fig. 1) showed the tumor plainly outlined within the thyroid cartilage. A month later the wound was well healed around the tube, and the patient was in good condition for further surgical treatment.

The tumor was so large and attached by such a wide base that it was deemed impracticable to attempt its removal perorally; laryngofissure was therefore decided on. When the split margins of the thyroid cartilage were spread apart,

Fig. 1.—Roentgenogram made after trachectomy, showing the tube in the trachea and the outline of the tumor within the larynx.

the tumor was seen to be attached to the right vocal cord and its vicinity. Its attachment was vascular, and bleeding was troublesome. The patient suffered no particular shock or distress after the removal of the tumor, was up and about on the following day and made a rapid recovery. Within three months he acquired a fairly good speaking voice. When he was examined a year later, it was noted that the larynx functioned well, producing a loud but rather harsh voice, and there was no indication within of a recurrence of the tumor.

After removal, the tumor was found to measure approximately 4 by 3.5 by 3 cm. It had the appearance of a fibroma, and the diagnosis of goiter was not established until sections had been made. The sections (fig. 2) showed the tumor to consist entirely of thyroid tissue, with no evidence of accompanying malignant growth. With this finding and with the passage of a year without signs of recurrence, it is assumed that this tumor developed as merely a progressive increase of glandular tissue.

Fig. 2.—Section of the intralaryngeal tumor, showing thyroid tissue.

Also, since this tumor had no traceable connection with the thyroid gland, which was demonstrated to be present in the usual location and appeared to be entirely separated from it by the unbroken surface of the thyroid cartilage, it may properly be classified as a true aberrant intralaryngeal goiter.

SUMMARY

The present theory of tissue rests along the embryonal tract does not fully explain the occurrence of aberrant goiter in locations outside the usual course of embryonal descent.

True aberrant goiter in any location is seldom observed. Within the larynx it is extremely rare.

A case is reported of aberrant intralaryngeal thyroid tumor, with recovery and nonrecurrence, in a man 51 years old.

OTITIC MENINGITIS

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Meningitis of otitic origin is usually a fatal disease. It is likely to become a preventable disease in due time. It taxes the mental faculties and the physical energies of all concerned in the care of the patient.

Those who have the responsibility of caring for patients with otitic meningitis and those who have the opportunity to observe the course of the disease need not be reminded of the state of utter helplessness in which the physician finds himself as he endeavors to save the patient's life or of the despondency which seizes him as each new and promising line of attack eventually fails. However, it behooves all physicians to evaluate again their working knowledge of otitic infections and their complications.

The lesion in meningitis of otitic origin is a variable one. A satisfactory statement regarding the lesion was made by Watkyn-Thomas,[1] who said: "When we speak of 'meningitis of aural origin,' we usually mean a leptomeningitis. 'Basal' or 'vertical,' 'benign' or 'malignant,' 'localized' or 'generalized,' 'serous,' 'sympathetic' or 'suppurative' describe manifestations of one common process: a pyogenic inflammation, as modified by the virulence of the infecting organism and by the local and general resistance brought into action against it."

The incidence of otitic meningitis is greater among young people, probably because there is more disease of the ears among children than in any other age group. The incidence is also greater in some localities than in others. At the Trinity Hospital my associates and I observe more than the average number of cases of this disease, because our ambulance service extends into a territory where poverty, poor hygiene, negligence and indifference to disease are conducive to the development of a more extensive pathologic condition than is usually permitted under better circumstances.

Presented at the monthly conference of the staff of Trinity Hospital, Brooklyn, March 14, 1934.

The pertinent features of this paper formed part of my scientific exhibit on "Roentgenologic Aspects of Mastoiditis" presented at the Eighty-Seventh Annual Session of the American Medical Association, Kansas City, Mo., May 7 to 11, 1936, and at the Convention of the American Academy of Ophthalmology and Otolaryngology in New York, Sept. 28 to Oct. 2, 1936.

1. Watkyn-Thomas, F. W., and Yates, A. Lowndes: The Principles and Practice of Otology, London, H. K. Lewis & Co., Ltd., 1932.

Otitic meningitis occurs spontaneously and postoperatively. A report of a study of some 8,000 cases of suppuration of the middle ear showed an incidence of 2.2 per cent of intracranial complications of spontaneous origin, whereas the postoperative incidence was considerably less. One may conclude from this study that the symptoms and other factors that would indicate surgical intervention are overlooked or else that the patient requiring medical or surgical care appears before the physician much too late in the course of the disease. It is a question whether complications are more frequent with acute than with chronic involvement.

The recognition of two postulates will clarify the considerations of symptoms, diagnosis and treatment. They are: 1. There is an anatomic and bacteriologic predisposition to otitic meningitis. 2. The treatment of otitic meningitis is prevention.

By anatomic predisposition is meant that particular condition of the temporal bone on roentgen examination which signifies either a state of nondevelopment or a state of partial development with a superimposed sclerosing process. Such a bone offers no system of mastoid cells with its large surface area of lining membrane, to act, as it were, like a sponge or a buffer mechanism to a spreading otitic infection. The spread must necessarily involve either the large venous channels, producing sepsis, or the smaller venous channels which lead to the meninges, producing meningitis. Anatomic predisposition labels a patient "a candidate for intracranial infection." The determination of such anatomic predisposition is made solely by roentgen examination.

On the roentgenogram, a mastoid is recognized as being pneumatized or non-pneumatized, developed, partially developed or undeveloped. The bone is spoken of as pneumatic, diploic or sclerotic. As a matter of fact, there may be any combination of these characteristics in a single mastoid process.

The developed, or pneumatic, mastoid (fig. 1) when infected usually drains well; when broken down it perforates through the cortex as a rule. In few instances does infection of such a mastoid eventuate in otitic meningitis; when it does, it is usually as a postoperative sequel.

The undeveloped mastoid, otherwise known as the acellular, infantile or non-pneumatized mastoid, ordinarily presents a thick cortex of compact bone and a thin inner table. The roentgen appearance may vary to the extent that some mastoids may have no cells visible at all (fig. 2), others may show a few cells surrounding the antrum or a group of cells in the tegmen bounding the floor of the middle cranial fossa (fig. 3) and still others may show a group of cells overlying the knee of the sigmoid sinus (fig. 4). This anatomic picture results from infection of or other trauma to the mucosa of the middle ear early in life, prior to the age at which the process of pneumatization of the

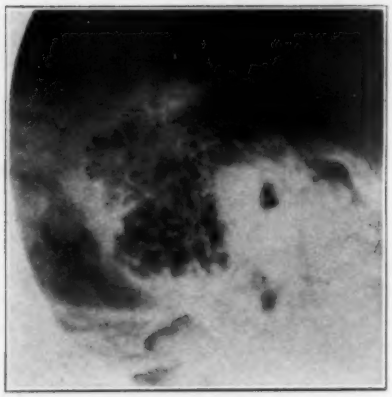

Fig. 1.—Pneumatized or fully developed mastoid. Note that both the course of the sigmoid sinus and the line of the tegmen which marks the floor of the middle cranial fossa are obscured and not definable because of the normal development of a spongelike cell system.

Fig. 2.—Undeveloped mastoid. Note that no cells are visible. The course of the sigmoid sinus and the line of the tegmen are distinct. The elevation in the line of the tegmen is that of the arcuate eminence and corresponds to the position of the superior semicircular canal.

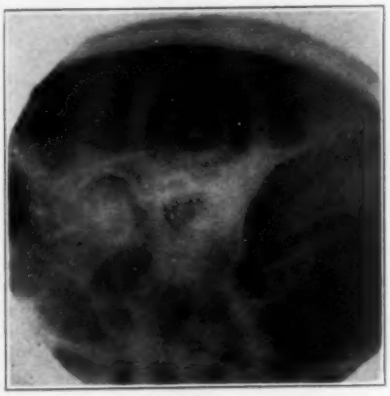

Fig. 3.—Undeveloped mastoid showing a group of cells in the tegmen line. Note the tortuous emissary vein and the sharp outline of the sigmoid sinus.

mastoid is initiated or before the process of pneumatization becomes completed (fig. 5).

In this type of mastoid, the areas which should have been pneumatized, and which undoubtedly would have been pneumatized were it

Fig. 4.—Undeveloped mastoid showing a group of cells overlying the knee of the sigmoid sinus. Note the diploic bone extending from the line of the sinus plate backward to the posterior border of the mastoid process.

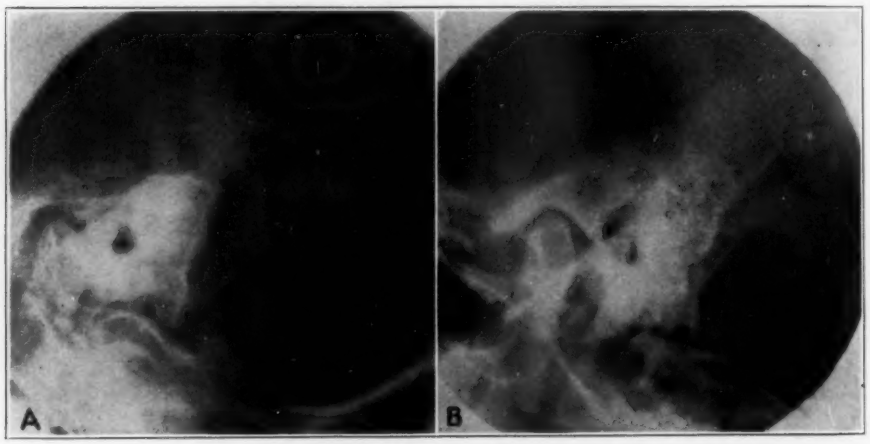

Fig. 5.—Undeveloped mastoid. *A*, the absence of pneumatization and the size of this mastoid comprise the typical picture which results from injury to the mucosa of the middle ear prior to or during the time when the process of pneumatization of the mastoid is initiated.

B, note that a few cells are discernible posterior to the sinus plate and also in the angle between the tegmen and the knee of the sinus. This illustrates a state of partial development, in which arrest of pneumatization occurred before that process became completed.

This interference with pneumatization is produced by otitic infection between the ages of 2 and 5 years.

not for injury to the mucosa, are occupied by diploic bone, which must be considered normal skull bone. However, long-continued irritation of repeated or chronic infection, with its change in equilibrium between the local blood supply and the local calcium supply, often results in an added deposit of lime salts onto this normal diploic bone, producing sclerosis. Sclerosis may be looked on as nature's successful effort to heal when infection has existed, but when there is no history or evidence of previous infection, sclerosis should be considered a result of a disturbance in the chemistry of the local tissue brought about by changes in the blood supply.

Otitis media and its concomitant infection of the antrum in an undeveloped mastoid may or may not drain well. Should the antrum contain excessive or swollen chronic granulations, drainage will be impeded. If some cells are present in this mastoid and they too become

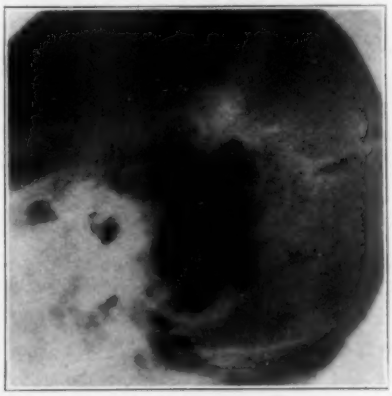

Fig. 6.—This temporal bone had been subjected to a simple complete mastoidectomy. Note the triangle made up by the posterior canal wall, the line of the tegmen and the sinus groove, in the center of which the external semicircular canal is visible. This triangle corresponds to the base of the petrous pyramid; it corresponds also to the size and shape of an undeveloped mastoid, such as that shown in figure 5 *A*. The operative removal of bone external to this triangle is equivalent to the removal of the compact cortex of an undeveloped mastoid, and thus enables one to visualize the inner structures, from which the pathways of extension of infection spring.

infected, their drainage will depend on the condition of the drainage from the antrum. With impeded drainage, and a spread of infection, as happens on occasion, there is little likelihood of perforation of the cortex because of its thick, compact structure. A pathway of extension of infection through the cortex would be the path of greatest resistance. The spreading infection will follow the path of least resistance. In the case of the undeveloped mastoid, there are several paths offering little resistance, all of which, sooner or later, lead to the meninges (fig. 6).

Pathways of extension to the intracranial structures are determined by the structural peculiarities of an individual mastoid process and by the richness of the venous channels in or near the infected area. The pathways may be grouped as follows:

A. Through the middle ear and antrum
   1. Upward, through the tegmen, either along the system of venules which traverse the tegmen to communicate with the veins of the dura or by contiguity and through dehiscences in the bone; spread of infection in this direction eventuates in an epidural abscess, an abscess of the temporosphenoid lobe or meningitis
   2. Inward or medially
      a. Through the labyrinth the spread is along the sheaths of the seventh and eighth nerves, through the internal auditory meatus and to the meninges of the posterior fossa or else through the aqueduct of the cochlea or the aqueduct of the vestibule
      b. Around the labyrinth, into the petrous pyramid, thence through the apex to the meninges
   3. Downward, by venous channels running from the middle ear into the jugular bulb, whence, by means of retrograde phlebitis or of thrombosis, the spread of infection reaches the meninges

B. Through the mastoid cells
   1. Upward to the middle fossa (as described in A 1)
   2. Inward, by way of the perilabyrinthine cells to the petrous pyramid and thence through the apex to the meninges
   3. Posteriorly, through the inner table to the cerebellum, producing cerebellar abscess or meningitis of the posterior fossa
   4. In various directions to reach the sigmoid sinus, producing perisinuous abscess, sinus phlebitis or sinus thrombosis
   5. Downward to the jugular bulb by spread through the peribulbar cells

In other words, it may be said that infection may travel to the intracranial structures by direct extension through the bone and by venous channels. The meningeal lesion is the result of travel of infection along the veins, beginning with the larger venous sinuses and ending in the pial and superficial cerebral veins. All these pathways carry infection to the meninges. The clinical picture terminates with septicemia, pyemia, edema and death. Pathologists have often assumed that because no gross evidence of the pathway of infection was obtained at the postmortem examination, the spread of infection was by way of the lymphatics. Turner and Reynolds [2] have disproved this contention by showing that there is no continuity of the lymphatics between extracranial and intracranial structures.

The first postulate mentions a bacteriologic predisposition. By this is meant that certain infections of the ear are more likely than others to

2. Turner, A. Logan, and Reynolds, F. Esmond: Intracranial Pyogenic Diseases, London, Oliver & Boyd, 1931.

eventuate in intracranial infection because of the type of invading organism. When culture reveals Streptococcus haemolyticus or Streptococcus mucosus-capsulatus to be the invader, the patient should be labeled a candidate for intracranial infection, because both these organisms have a reputation for infecting the meninges. Streptococcus haemolyticus has a particular liking for the sigmoid and other venous sinuses, frequently producing thrombosis. B. mucosus-capsulatus (Streptococcus or Pneumococcus type III) seems to have an affinity for the smaller venules and usually produces widespread phlebitis, which terminates in diffuse leptomeningitis. Even though other organisms have been found responsible for otitic meningitis, the two mentioned are the most frequent and the severest offenders. Although there is no assurance that meningitis will result when they are recognized on culture, it is wise to label the patient a candidate for intracranial infection.

The second postulate states that the treatment of otitic meningitis is prevention. In a simple otitic infection the clinician should determine by careful roentgen and bacteriologic examination whether or not the patient is to be labeled a candidate for intracranial infection. In a patient so labeled, the finer variations in symptoms must be ascertained; a likely pathway for the spread of infection ought to be considered, and suitable treatment for the simple otitis should be instituted. If in the course of treatment the infection spreads and produces one or more intracranial signs or symptoms, immediate surgical intervention is indicated. The surgeon should open the antrum, expose the dura and the sigmoid sinus and lay open any anatomic pathway of infection which he may have suspected on the roentgen film to bring about the fullest facility for drainage. In addition, an attempt to raise the resistance factors to a higher level should be made by means of the various forms of hemic therapy, nonspecific therapy with foreign proteins and the use of specific serums. For a mastoid which had been operated on previously and is the seat of a spreading infection, revision operation and exploration without delay are indicated.

Thus, if the infection is walled off and the focus is eradicated, recovery is possible. But if the infection is virulent and has spread beyond the surgical field, recovery is rare.

The symptoms are extremely variable; there may be but one, or there may be a complex variety. Much too often the early symptoms are so vague as to obscure the issue until the meningitis is evident. Three early symptoms are headache, fever and stiff neck. They should immediately lead to a diagnosis of meningitis. Examination of the spinal fluid is helpful in determining the state of the meningeal infection. A sterile fluid should not negate a diagnosis of meningitis, for the infecting organism may not yet have reached the cerebrospinal fluid, whereas its toxins may be present in abundance.

Since intracranial complications often terminate in meningitis, early recognition of involvement of the venous sinuses, epidural abscess, cerebral abscess and infection of the petrous pyramid is of vast importance. Transient edema, occurring behind the tip of the mastoid, indicates pressure on the lateral sinus and slowing or complete cessation of the current in the sinus. This finding should lead to a diagnosis of perisinuous abscess or sinus thrombosis. In abscess, either epidural or cerebral, the predominant symptom is persistent headache, persistent because of the constant pressure on the nerves of the dura. Pain back of the eye of a patient who has been operated on and still has discharge from the ear should indicate involvement of the petrous pyramid. Ophthalmoscopic findings are sometimes confusing and seldom helpful in the diagnosis of early intracranial infection.

The treatment of otitic meningitis after the infection is full blown has been attended with little or no success. Repeated spinal tapping has been practiced for many years. The results are not encouraging. The wisdom of such treatment per se is questioned by some workers.

Kolmer [3] and his co-workers have performed a series of experiments on animals to determine the treatment of meningeal infection from an immunologic point of view. They have tried chemotherapy and serotherapy by intracarotid and intravenous injection, alone and in combination with cisternal drainage and lavage. They have attempted also to evaluate the use of autogenous vaccines in pneumococcic and streptococcic infections of the ear and nasal sinuses, by establishing the identity of the invader early in the course of the disease, preparing an autogenous vaccine and administering the vaccine before and after operative procedure. Their reports are optimistic.

Were each case of infection of the middle ear studied bacteriologically and were it possible to produce immune serums for the patients, there can be little doubt that a most powerful weapon would be available for the treatment of both the primary and the secondary lesion.

Kubie [4] described a method of forced spinal drainage, which has yielded a few satisfactory results. He stated that the perineural and perivascular spaces hold many of the invading organisms which may be washed away by increased production of spinal fluid. He therefore

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3. Kolmer, John A.: The Chemotherapy and Serum Therapy of Pneumococcus and Streptococcus Meningitis: VII. The Intracarotid Treatment for Experimental Pneumococcus Meningitis, Arch. Otolaryng. **9**:509 (May) 1929. Kolmer, John A., and Amano, K. W.: The Specific Prophylaxis of Pneumococcus and Streptococcus Meningitis: I. Serum Prophylaxis, Arch. Otolaryng. **14**:125 (Aug.) 1931; II. Vaccine Prophylaxis, ibid. **15**:547 (April) 1932.

4. Kubie, Lawrence S., quoted by Kerrison;[5] in discussion on Kerrison,[5] p. 675.

administers hypotonic solutions intravenously to increase the production of cerebrospinal fluid and simultaneously drains the fluid by spinal tap, either continuously or by repeated puncture at stated intervals.

Kerrison [5] pondered on the advisability of surgical drainage of the central basal cisterns, the cisterna pontis and the supratentorial and infratentorial basins, in combination with Kubie's method of drainage. He has outlined an experimental technic which possesses much rationale because it is designed to drain those spaces found on postmortem examination to contain pools of infection. It would seem that the amount of surgical treatment required must be attended by overwhelming shock to an already debilitated cerebrospinal system. The difficulties with any method of drainage result from stasis, wherein either more fluid is secreted than drained or not sufficient drainage is possible. It is for this reason that Kerrison suggests multiple points of drainage for the walled off pockets and dead spaces formed by adhesions. Injections of air through the spinal column combined with early institution of drainage might prevent the formation of these dead spaces. Wide opening of the skull to secure drainage permits collapse of the meninges and movement of the brain and then a settling on the base, with partial obstruction. Therefore it is necessary to prevent collapse as well as to establish drainage.

The possibility of draining the basal cisterns through the nasal cavity has been suggested. Even though this offers little hope for success because of the present restricted field of surgical approach, there still is a possibility that it will become a method of choice in selected cases. Eagleton,[6] in an article summarizing his more recent experiences with meningitis, pointed out the probability of latent infection of the sphenoid sinus causing meningitis in cases of otitic infection. He expressed the belief that mastoiditis is a concomitant and secondary lesion to the disease of the sphenoid sinus. In a measure, this contention is justifiable. Unfortunately, it is rarely possible to make simultaneous clinical diagnostic studies of the paranasal sinus system and the temporal bone in cases of acute involvement. In the event of more frequent studies of this comprehensive nature and the pinning of positive findings onto the sphenoid sinus, a line of attack may be devised to include the nasal cavities. Looking on Eagleton's contentions from a prophylactic point of view, the clinician should include in his routine diagnostic studies of otitic infection a consideration of the nasal sinus system. This consideration should be anatomic, bacteriologic and functional, as pertaining to the ciliary activity of the mucosa of the sinuses.

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5. Kerrison, Philip D.: Treatment of Otitic Leptomeningitis, Ann. Otol., Rhin. & Laryng. **41**:651 (Sept.) 1932.

6. Eagleton, Wells P.: Suppurative Meningitis of Otitic and Nasal Origin, Arch. Otolaryng. **15**:885 (June) 1932.

Admitting, as physicians do, that treatment of otitic meningitis has been, and still is, unsuccessful in the vast majority of cases, one ought to approach the problem from another angle. The treatment of otitic meningitis should be prevention. Prevention consists of labeling each patient with suppurative otitis as a candidate or a noncandidate for intracranial infection. The pneumatic mastoid when infected will produce the classic picture of mastoiditis. However, the undeveloped mastoid when infected will not produce the classic picture of mastoiditis. When infection does spread, the clinician who has labeled the patient properly will be aware of the situation and act accordingly.

If patients who are candidates for intracranial infection are relieved of the focus of infection by free surgical drainage when they evidence irritation of the dura or invasion of the blood stream, the incidence of otitic meningitis should be diminished.

50 Plaza Street, Brooklyn, N. Y.

THE GREAT VESSELS IN DEEP INFECTION OF THE NECK

L. C. BOEMER, M.D.
ST. LOUIS

After having observed near-fatal cases and then a fatal case of deep infection of the neck secondary to tonsillitis and peritonsillar abscess, I reviewed seventy-five recent cases of deep pus in the neck to determine what constituted the greatest hazard to life. Burrowing of the abscess to the surface and adequate timely drainage aided by local and supportive measures accounted for recovery in seventy-three of the seventy-five cases. With the exception of four, the cases were observed at the St. Louis Children's Hospital and the Barnes Hospital in 1934, 1935 and 1936.

Survey of Seventy-Five Cases of Deep Infection of the Neck

Twenty-Six in Adults

9 from lower third molar tooth
7 from cervical glands
3 from tonsil (one death; autopsy)
2 from mastoid (one death; autopsy)
5 from miscellaneous sources
- Fracture of mandible
- Ten days after tonsillectomy
- Carcinoma of nasopharynx
- Carcinoma of larynx
- Source unknown

Forty-Nine in Children

38 from retropharyngeal lymph glands
11 from deep cervical glands

One of the two deaths followed neglected mastoiditis and was unavoidable. The other followed tonsillitis and peritonsillar abscess. The presence of deep pus in the neck was unrecognized until the patient was moribund.

In the patients who recovered after the formation of deep pus in the neck secondary to tonsillitis and peritonsillar abscess, it was possible to drain the pharyngomaxillary space by advancing a curved blunt hemostat through the incision previously made for peritonsillar abscess. The patients had the cardinal signs of involvement of the anterior

From the Department of Otolaryngology, Oscar Johnson Institute, Washington University School of Medicine. This investigation was made possible by the Frank E. Ball Research Fund.

compartment of the parapharyngeal space, namely, extreme trismus, induration about the angle of the jaw, median bulging of the pharyngeal wall and septic fever. Recovery was aided by hot irrigations with a hypertonic solution of sodium chloride, high caloric feedings through a nasal tube and neoarsphenamine intravenously injected to counteract Vincent's spirochetes, which might have been factors in making the oropharyngeal infection so severe.

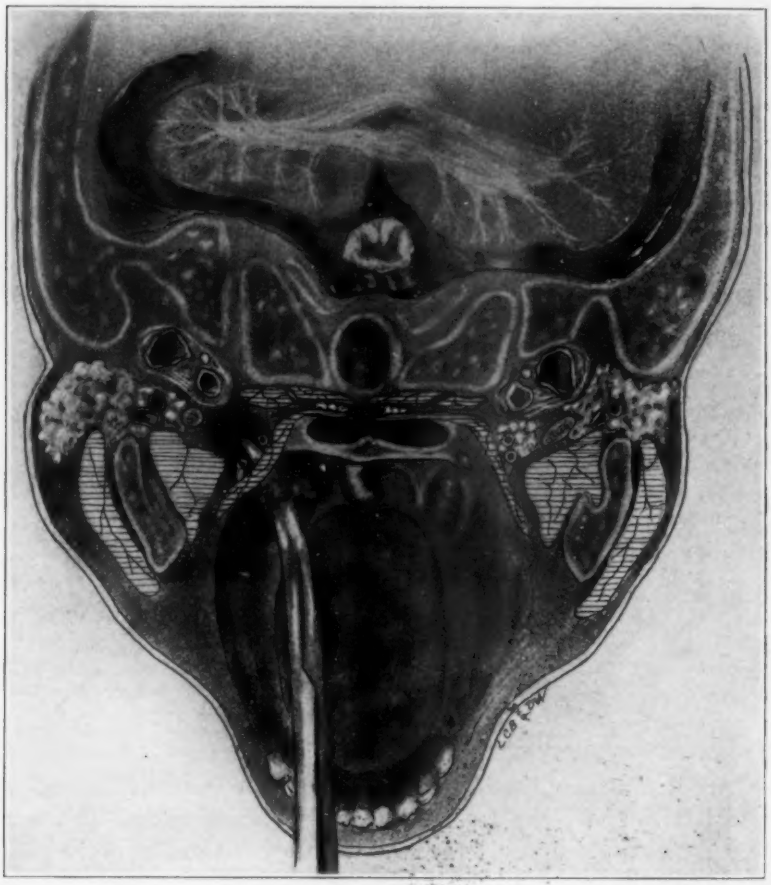


Fig. 1.—Cross-section through the tonsils and a pharyngomaxillary or parapharyngeal abscess showing forceps piercing the superior constrictor muscle of the pharynx and the proximity of the great vessels.

Figure 1, a cross-section through the tonsils partially diagrammatic on the right side, shows a curved forceps entering the parapharyngeal space through the superior constrictor muscle of the pharynx. Had the abscess extended to involve the great vessels in the posterior part of the para-

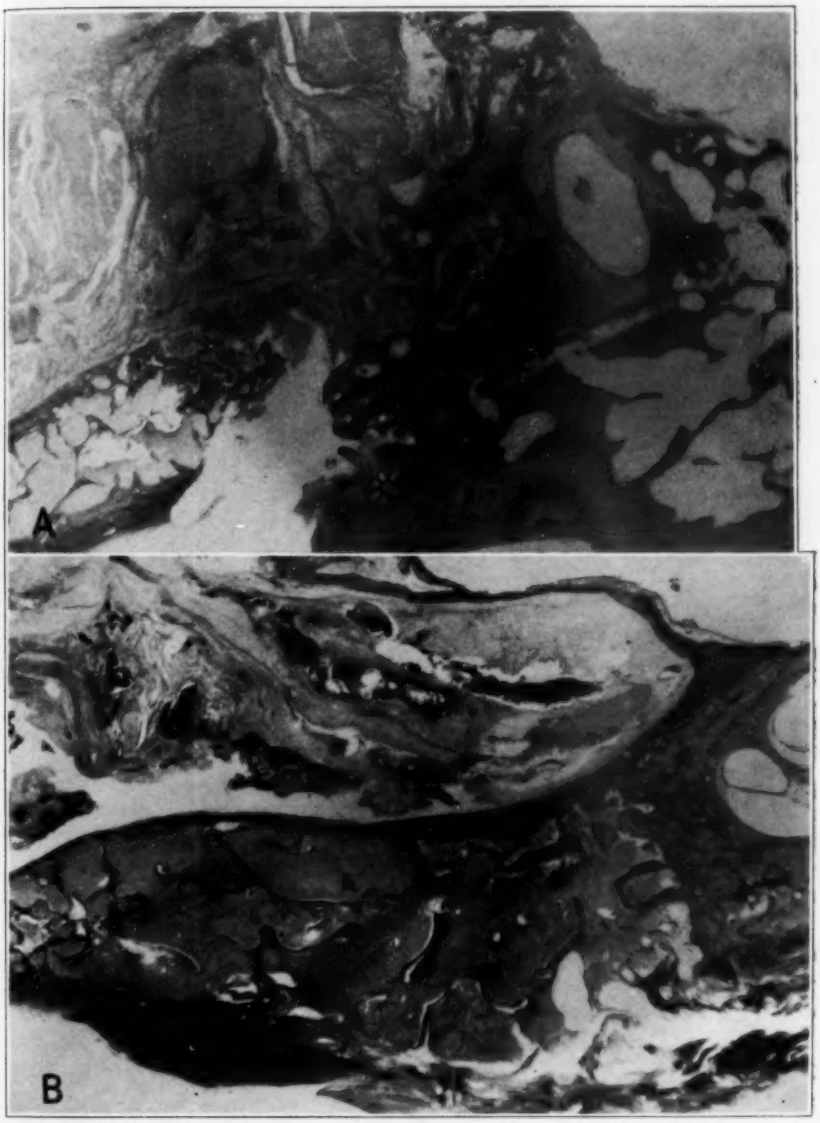


Fig. 2.—*A*, section of the base of the cranium, showing infiltration of the wall of the jugular bulb with pus within the lumen. The sphenoid bone shows early osteomyelitis. *B*, horizontal section through the carotid canal. The pericarotid venous plexus shows heavy infection. The internal carotid artery, completely collapsed, is shown in the cross-section.

pharyngeal space, this pharyngeal approach would have been of little or no value and life would have been sacrificed on the altar of conservatism.

The fatal case of tonsillar infection indicates that drainage should be external in practically all instances. A review of the positive features, together with a consideration of the anatomic structures and pathologic changes involved, may help to save some other person's life.

A white woman aged 22 entered the hospital on Nov. 2 and died on Nov. 6, 1935. Three weeks previous to entry she experienced sore throat and tonsillitis. One week previous to entry, her attending physician incised a peritonsillar abscess. On entry, she was stuporous, occasionally irrational or comatose and extremely

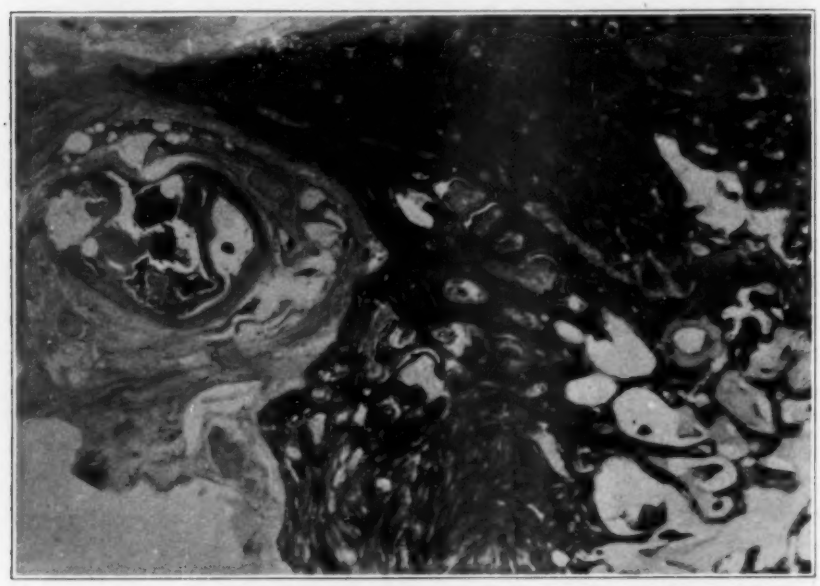


Fig. 3.—Section showing erosion of the wall of the internal carotid artery at the base of the temporal bone secondary to deep infection of the neck.

toxic, with edema of the right side of the face from behind the right mastoid to the right side of the nose and from the hair line down to the clavicle, hardness of the right parotid gland and indications of pneumonia.

The right tonsil was larger than the left but was not definitely more prominent in its position; on spreading the old incision disintegrating pus was obtained. The nose was normal anatomically and showed no obstruction or free pus. A nasopharyngoscopic examination was not done. A serosanguineous exudate was noted to come from a pinpoint opening in the right ear drum; the drum membrane was incised, yielding bloody serum, which contained Staphylococcus aureus-haemolyticus. There was also edema, of sanguineous appearance, involving the conjunctiva of the right eye. The eyegrounds were normal.

External incision and drainage had no effect on the final outcome. Pus extended into the parotid compartment, causing necrosis of the gland with formation of a large abscess. Culture yielded Staph. aureus-haemolyticus.

At the autopsy a portion of the base of the skull was removed for serial section. Figure 2 *A* is a photomicrograph of the base of the cranium, showing pus within the lumen of the jugular bulb, accounting for the many metastatic pulmonary abscesses. Early osteomyelitis of the sphenoid bone was noted microscopically, and pus was noted macroscopically extending up from the neck through the base of the skull, causing basal meningitis and peripheral abscess of the right temporal lobe of the brain. The sections showed infection of the retropharyngeal lymph glands. Figure 2 *B* is a horizontal section through the carotid canal, showing heavy infection in the pericarotid venous plexus accounting for thrombosis of the right cavernous sinus.

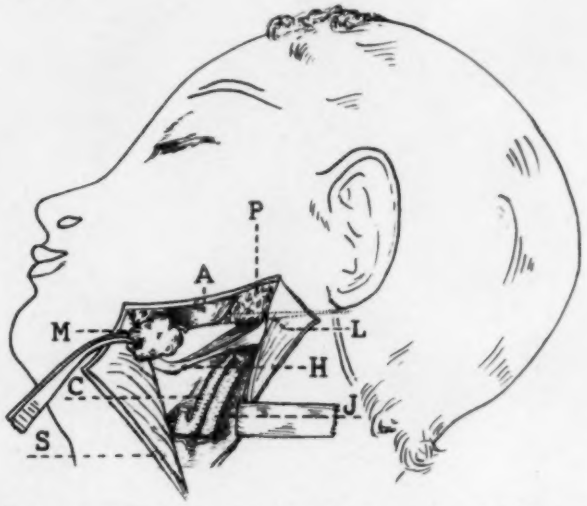


Fig. 4.—External approach to pus deep in the neck. *S* indicates the carotid sheath; *C*, the internal carotid artery; *M*, the submaxillary gland; *A*, the angle of the mandible; *P*, the parotid gland; *L*, the stylomandibular ligament; *H*, the greater horn of the hyoid bone, and *J*, the internal jugular vein.

The deep cervical spaces involved included: first, the parapharyngeal space with its anterior compartment separated from the tonsil only by the superior constrictor muscle of the pharynx and its posterior compartment containing the great vessels of the neck; second, the parotid space; third, the submaxillary space, and fourth, the retropharyngeal space.

The parotid space was involved by extension from the parapharyngeal space. A portion of the parotid gland and the internal pterygoid muscle against the ramus of the mandible form the external boundary of the parapharyngeal space. The medial boundary is formed by the superior constrictor muscle of the pharynx with its attached tonsil. The skull in the region of the jugular foramen forms the superior boundary. The great vessels run in the posterior compartment deeper than the styloid process. At the level just posterior to and deeper than the greater horn of the hyoid bone, the carotid sheath continues the space inferiorly through the neck.

Figure 3 is photomicrographic proof of extensive erosion of the wall of the internal carotid artery without actual rupture. This erosion occurred in the fatal case of deep pus in the neck secondary to neglected chronic purulent mastoiditis. Half of the wall of the jugular bulb was pathologically absent in connection with thrombophlebitis of the lateral sinus and the internal jugular vein.

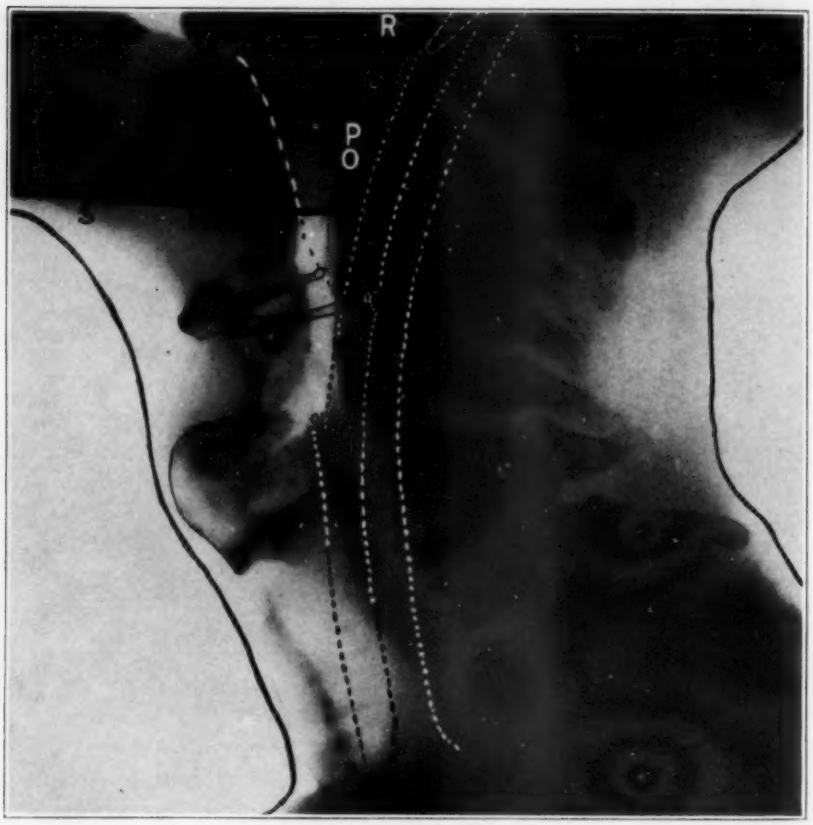


Fig. 5.—Deep pus in the neck secondary to cancer of the larynx. The anterior part of the parapharyngeal space is outlined by the superior constrictor muscle of the pharynx and the ramus of the mandible. The great vessels in the posterior part continue the space by way of the carotid sheath. All the spaces shown are intercommunicating. *S* indicates the submental space; *M*, the submaxillary space; *P*, the parotid space, and *R*, the retropharyngeal space.

In instances of imminent and actual involvement of the great vessels of the neck, early adequate external drainage of the deep pus is indicated. The line of incision through the skin is of secondary importance, except that small incisions lead to timid surgical intervention. Figure 4

shows the T flap incision indicated for thorough exploration. The main surgical landmarks are the greater horn of the hyoid bone and the tip of the styloid process.

When the parapharyngeal space beneath the angle of the jaw is entered, the styloid process is sought with the gloved finger posteriorly and externally. The anterior compartment (prestyloid) is explored, or the great vessels of the neck (poststyloid) are followed to the base of the skull. The carotid sheath may be easily followed down through the neck. At the greater horn of the hyoid bone, the internal jugular vein reaches its most superficial location, and here also the common facial vein pierces the carotid sheath to enter the internal jugular vein. If the submaxillary gland is raised out of its bed, the common facial vein may be ligated. If indicated, because of sepsis, the internal jugular vein may be ligated to prevent dissemination of infection.

Figure 5 is a roentgenogram showing deep pus in the neck requiring drainage and associated with advanced carcinoma of the larynx. The arytenoid cartilages and a portion of the thyroid cartilage have been destroyed by the cancer. The pharynx is outlined, owing to its air content. This funnel-shaped cavity is mainly bounded by the constrictor muscles of the pharynx extending from the base of the skull downward past the greater horn of the hyoid bone. With the ramus of the mandible plainly visible on the outside and the superior constrictor muscle of the pharynx visible on the inside, the outline of the anterior compartment of the parapharyngeal space is easily conceived from this roentgenogram. The great vessels in the posterior compartment continue the space through the neck by way of the carotid sheath. All the spaces shown are intercommunicating and are potential abscess cavities, but involvement of the parapharyngeal space with its contained internal jugular vein and internal carotid artery constituted the greatest hazard to life.

SUMMARY

A survey of seventy-five cases of deep infection of the neck was made.

There were two deaths in the entire series: one (unavoidable) followed neglected mastoiditis; the other death, from deep pus in the neck (unrecognized until the patient was moribund), followed tonsillitis and peritonsillar abscess.

Suppuration of the retropharyngeal glands or of the deep cervical glands accounted for the condition in the forty-nine cases in children, and all the patients recovered.

Involvement of the lower third molar tooth accounted for the condition in one third of the cases in adults.

Involvement of the pharyngomaxillary or parapharyngeal space and the great vessels of the neck constituted the greatest hazard to life.

CONCLUSIONS

Fatality from unrecognized deep pus in the neck secondary to tonsillitis and peritonsillar abscess still occurs.

Early adequate drainage of the parapharyngeal space must be obtained and this is best achieved externally.

Beaumont Medical Building.

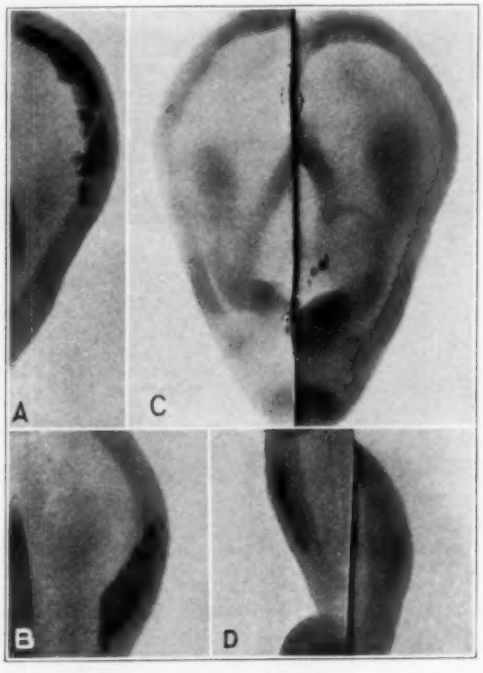
Clinical Notes

BONY DEPOSITS IN THE AURICLE

J. H. Childrey, M.D., San Francisco

Reports of ossification of the auricular cartilage are infrequent.[1] I report herein four additional cases.

All the patients were elderly men. The general physical examinations revealed nothing except myocarditis in case 2. The patient in case 4 had had syphilis



A, roentgenogram of the left ear of patient 1; the bone apparently developed from several centers of calcification. A roentgenogram of the right ear showed no bone. *B*, roentgenogram of the helix of the left ear of patient 2. *C*, roentgenograms of the ears of patient 3, showing thickened cartilage in the antihelix and the lower scaphoid fossa of each ear; this was of bony hardness. There was a tiny piece of bone in the helix of one ear, and several small pieces of bone were present in the concha of the other. *D*, roentgenograms of the helix of both ears of patient 4.

1. Higbee, D. R.: Calcigerous Metaplasia of the Auricular Cartilage, Arch. Otolaryng. **14**:70 (July) 1931. Childrey, J. H.: Calcigerous Metaplasia in the Auricle, ibid. **15**:883 (June) 1932.

previously, and at the time of examination he had retinitis proliferans of tuberculous origin. The histories of all were negative for frost-bite or other trauma to the ears. There was nothing in the appearance of the affected ears to indicate the presence of bone, which was discovered only by palpation and roentgen examination.

INSTRUMENTS FOR USE IN SURGERY OF THE PETROUS PYRAMID

M. C. Myerson, M.D., New York

RETRACTOR

A retractor is offered for use in the operation for exposing the inferior aspect of the petrous pyramid. It is made in two sizes, for children and for adults. Because of the depth of the space in which the operator works when attacking this area, it is necessary to have retractors of special design. After the superficial fascia is

Fig. 1.—The retractor.

Fig. 2.—The dissector.

divided, retraction becomes necessary to protect the carotid sheath, keep the facial nerve out of the field and, at the same time, remove from the field of vision the sternocleidomastoid muscle, the posterior belly of the digastric muscle and the muscles attached to the styloid process.

Further retraction is then made on the pharyngeal muscles upward and inward and includes the palatal muscles. The objective of the retraction is the exposure of the area of the attachment of the tendinous portion of the levator palatini muscle and of the pharyngeal aponeurosis.

DISSECTOR

The dissector is used to expose the quadrilateral plate of bone which constitutes the floor of the carotid canal. In order to do this it is necessary to strip part of the attachments of the levator palatini muscle and of the pharyngeal aponeurosis from this plate of bone.

ANGULAR BUR

The bur is used for penetrating the quadrilateral plate of the inferior aspect of the petrous bone after it has been exposed. It is important to keep this instrument well confined to this plate of bone, away from the carotid artery laterally and the foramen lacerum medially. The bur must be used in a posteromedial direction. In a living patient either pus or softened bone would be encountered in this region, so that penetration might not be necessary, or if so, easily accomplished.

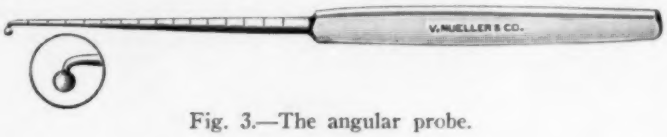


Fig. 3.—The angular probe.

Fig. 4.—The angular bur.

This bur is of value in opening into the apex of the petrous bone through its roof after elevation of the temporal lobe of the brain.

It is also of value in removing bone around the semicircular canals and in finding the starting point of tracts of softened bone. The distal portion is calibrated in centimeters.

ANGULAR PROBE

This is a safe instrument for use in surgical intervention on the mastoid and the petrous pyramid. In addition, it is used to lift the carotid artery out of its bed after part of the quadrilateral plate of bone has been removed. It is calibrated at its distal end in centimeters.

AN OPERATION TO REPAIR LATERAL DISPLACEMENT OF THE LOWER BORDER OF THE SEPTAL CARTILAGE

LYNDON A. PEER, M.D., NEWARK, N. J.

Lateral displacement of the lower free border of the septal cartilage, with protrusion of the displaced cartilage into one nostril is a condition observed in many patients consulting rhinologists for relief of nasal obstruction. In such cases the free border of the septal cartilage, instead of occupying its normal midline position between the two skin folds of the columella, protrudes into one nostril, pulling the columella toward the side of the protrusion. There are also depression of the nasal tip due to the absence of septal support and enlargement and distor-

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Presented before The Ear, Nose and Throat section of the Academy of Medicine of Northern New Jersey, Dec. 14, 1936.

tion of the opposite nostril (fig., *A*). A conventional submucous resection in such cases obviously fails to improve breathing, because the displaced buttress of cartilage left anteriorly still protrudes into the nostril. Surgeons operating on a considerable number of patients with this condition have successfully corrected the deformity by freeing the anterior displaced portion of septal cartilage, making a hinge by an incision through the cartilage at the angle of deflection and

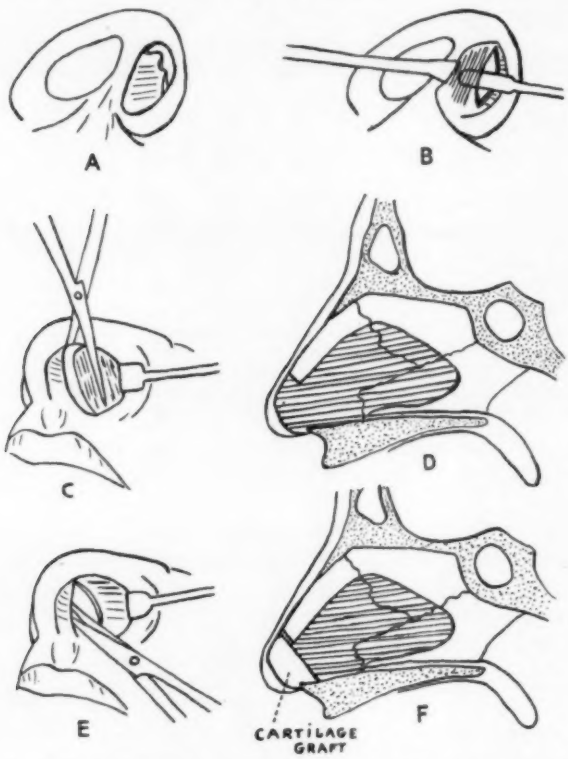

Figure.—*A*, displacement of the anterior free border of the septal cartilage into the left nostril. The columella is pulled toward the left; the nasal tip sags, and there is distortion of the right nostril. *B*, an incision has been made over the free lower border of the septal cartilage, and the mucous membrane is being elevated on the right side. Later the mucous membrane is elevated on the left side, completely exposing the cartilage. *C*, excision of the distorted lower segment of the septal cartilage with the scissors. *D*, diagram of a cross-section of the nose after removal of the anterior cartilage segment and the remaining septal components. The shaded area represents the amount of septal cartilage, ethmoid bone and vomer removed. Note that the supporting buttress of cartilage at the tip has been excised. *E*, a pocket is made in the columella extending from the region of the nasal spine to the nasal tip. A piece of cartilage is then cut from the large segment, removed with the Ballenger swivel knife and inserted in this pocket. The dimensions of this free cartilage graft are such that it extends from the nasal spine to the tip and from the tip back to the beam of cartilage supporting the dorsum of the nose. *F*, diagram of a cross-section of the nose showing the cartilage graft in place.

holding it between the skin folds of the columella with a mattress suture. Metzenbaum's operation [1] is illustrative in principle of this type of repair.

There are a number of cases, however, in which the displaced lower border of septal cartilage is so distorted and bound down by fibrous tissue that it will not provide adequate support for the tip when replaced. The operation herein described may be used to correct this type of displacement. This procedure has been used by me and by the house doctors in my service in eighty-five cases in six years, with good average results. We had one failure due to infection, with loss of the cartilage graft, but the nose was repaired later with a fresh graft of septal cartilage taken from another patient.

PROCEDURE

A strip of sterile gauze soaked in a solution of 5 per cent cocaine is inserted in each nasal cavity, and a 1 per cent solution of procaine hydrochloride is injected into the columella. An incision is made over the protruding free border of the septal cartilage down to the cartilage. The perichondrium and the mucous membrane are then elevated from each side of the cartilage, and the separation is carried as far back over the septal cartilage, the perpendicular plate of the ethmoid bone and the vomer as is desired (fig. *B*). The anterior displaced segment of septal cartilage is then completely removed, and the remainder of the septal cartilage is excesed with the Ballenger swivel knife, care being taken to leave a beam of cartilage along the dorsum of the nose for support (fig., *C* and *D*). The bony septal elements are removed when they are obstructive. A pocket is then made in the columella, through the original incision, extending up to the tip and down to the region of the nasal spine (fig., *E*).

The distance from the spine to the nasal tip is estimated, and a straight piece of cartilage of this height is cut from the large piece of cartilage removed with the Ballenger swivel knife. This segment of cartilage is inserted in the prepared pocket, resting in the region of the nasal spine below, supporting the nasal tip above and extending back to the beam of cartilage along the dorsum of the nose (fig., *F*). A mattress suture through the columella and the cartilage retains the graft in place and prevents bleeding. The excess of mucous membrane is then excised from the posterior lip of the incision, and the two edges are sutured with fine silk. Nasal tampons are placed in each nostril to prevent bleeding. The nasal tampons are removed in two days, and all sutures are removed at the end of five days.

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1. Metzenbaum, Myron: Replacement of the Lower End of the Dislocated Septal Cartilage Versus Submucous Resection of the Dislocated End of the Septal Cartilage, Arch. Otolaryng. **9**:282 (Feb.) 1929.

Abstracts from Current Literature

Ear

EARLY ASYMPTOMATIC ACOUSTIC TUMOR: REPORT OF SIX CASES. MARY HARDY and S. J. CROWE, Arch. Surg. **32**:292 (Feb.) 1936.

Examination of serial sections of the temporal bones of two hundred and fifty patients revealed a small acoustic tumor in six instances. Each growth was entirely within the internal auditory canal. The largest was about 5 mm. in diameter and the smallest about 0.25 mm. The vestibular nerve was involved by the tumor in four instances and the cochlear nerve in two. Histologically, five of the tumors were alike in cellular structure; they resembled large tumors observed on the acoustic nerve and in the cerebellopontile angle. The sixth tumor was different from any other growth seen in this region. An angiomatous network of blood vessels was present in three cases in which there was tumor and in seven of the other cases; the network involved the vestibular nerve. Both these lesions both the tumor and the angiomatous network, were asymptomatic. Irritative symptoms are not produced by growths that are too small to cause compression of the contents of the internal auditory canal.

GRANT, Philadelphia. [ARCH. NEUROL. & PSYCHIAT.]

PETROSISTIS AND A CONSIDERATION OF GRADENIGO'S SYNDROME: REPORT OF TWO CASES IN WHICH GRADENIGO'S SYNDROME OCCURRED. EUGENE L. BULSON, J. Indiana M. A. **29**:129 (March) 1936.

Gradenigo first described, in 1904, the symptom complex consisting of paralysis of the external rectus muscle of the eye occurring in the course of acute mastoiditis, associated with pain in the temporal and parietal regions of the same side. The first symptom to appear is a dull aching pain in and around the region of the eye of the same side as the otitis. The pain is deep seated, is more severe at night and is confined to the eye and the region over the eye. It is due to an irritation of the ophthalmic branch of the fifth nerve. The associated petrositis is accompanied by persistent otorrhea. Adequate drainage must be established before endocranial complications occur.

MILLER, South Bend, Ind. [AM. J. DIS. CHILD.]

THE MANAGEMENT OF BLOOD STREAM INFECTION FOLLOWING MASTOIDITIS. ELBRYNE G. GILL, South. M. J. **28**:830 (Sept.) 1935.

Gill recommends prompt and thorough drainage of the mastoid and careful inspection and palpation of the wall of the sinus in all cases of suspected infection of the blood stream in the presence of known mastoid infection, early ligation and drainage of the sinus and obliteration of areas of thrombophlebitis. He also advocates transfusions of whole blood whenever a need for them is indicated by the hemoglobin concentration, the erythrocyte count or the general condition of the patient.

SCHLUTZ, Chicago. [AM. J. DIS. CHILD.]

TRAUMATIC BILATERAL PARALYSIS OF THE SIXTH NERVE. P. DUPUY-DUTEMPS, Ann. d'ocul. **172**:707 (Aug.) 1935.

Dupuy-Dutemps reports a case of cranial traumatism followed by coma, hemorrhags from the ear, paralysis of the sixth nerve bilaterally and paresis of the right side of the face. Functional disturbances disappeared within a few months. The hypothesis of compression or, more probably, of contusion of both nerves is considered.

BERENS, New York. [ARCH. NEUROL. & PSYCHIAT.]

PHENOMENON OF THE "DEAD CHEEK" ACCOMPANYING THE VERTIGO OF MÉNIÈRE. F. J. COLLET, Rev. d'oto-neuro-opht. **13**:665 (Nov.) 1935.

This condition is described as a sensation of numbness of the ear and the corresponding cheek ("dead feeling") which accompanies intense vertigo. The histories of four patients, all near 50 years of age, are given in detail. Collet suggests that the most plausible explanation of the mechanism of this phenomenon is angiospasm of the vestibular centers or pathways, which extends into neighboring territory, the nuclei of origin of the trigeminus nerve. Paralysis of the facial nerve accompanying Ménière's vertigo is susceptible of the same interpretation.

DENNIS, San Diego, Calif. [ARCH. NEUROL. & PSYCHIAT.]

INFLUENCE OF SURGICAL INTERVENTION ON AND APPLICATION OF DRUGS TO THE LABYRINTH ON BODY POSTURE AND MOVEMENT. R. THAUER and G. PETERS, Arch. f. d. ges. Physiol. **235**:316, 1935.

After careful unilateral labyrinthine extirpation in frogs typical asymmetry in posture develops slowly; it appears at once after intracranial severance of the eighth nerve or after injection of cocaine into the labyrinth. The delay in the development of the asymmetry is due partly at least to the stimulating effect of the operation, which counteracts the loss of the labyrinthine impulses. Other factors seem to play a part. This is indicated by observations after bilateral labyrinthectomy. If the second labyrinth is removed several minutes after the first, the asymmetry following the first operation persists in some cases for a time after the second labyrinthectomy. This is explained by the assumption of an after-effect of the first labyrinthectomy on the whole central nervous system.

SPIEGEL, Philadelphia. [ARCH. NEUROL. & PSYCHIAT.]

FUNCTION OF THE OTOLITHS, STUDIED BY MECHANICAL STIMULATION OF THE UTRICULAR OTOLITH IN THE LIVING PIKE. H. ULRICH, Arch. f. d. ges. Physiol. **235**:545, 1935.

The otolith of the utriculus was stimulated by a standardized hair. Such stimulation induced reflex tonic ocular movements. Pressure on the otolith in the anterior and outward direction elicited deviation of the homolateral eye upward and backward, and pressure in the outward direction, vertical (upward) deviation. The contralateral eye moved in the opposite direction. Pressure on the otolith inward was ineffective. Rotation about the longitudinal axis of the body to the left stimulated the left labyrinth only, and rotation to the right, the right labyrinth only.

SPIEGEL, Philadelphia. [ARCH. NEUROL. & PSYCHIAT.]

EXAMINATION OF ROTATION OF THE EYES AFTER UNILATERAL EXCLUSION OF THE LABYRINTH. E. GOLLAS, Arch. f. Ohren-, Nasen- u. Kehlkopfh. **140**:340, 1936.

Gollas examined seven patients with one labyrinth destroyed and one normal according to Grahe's method for testing the rotation of the eyes. The patients were placed on Grahe's table and strapped down, so as to avoid reflex movements of the neck. The fundus oculi was inspected by means of Grahe's modification of Thorner's ophthalmoscope. The patient was turned first to the left side, and the deviation of the papilla was watched in the course of gradual turning to 20, 40, 60 and 90 degrees. In the course of the return to the normal position, the deviation of the papilla was again watched at the same degrees. Then the turn was made to the right side, and the same observations were made. Both eyes were examined in all cases. It was found that turning to the side on which the labyrinth had been destroyed resulted in normal rotation; however, turning to the side of the normal labyrinth resulted in reduced rotation. This indicates that rotation is regulated chiefly by the contralateral labyrinth but also slightly by the homolateral one. Moreover, each labyrinth acts on both eyes.

EDITOR'S ABSTRACT.

OTOMICROSCOPIC STUDY OF THE TYMPANIC MEMBRANE IN MASTOIDITIS. E. LÜSCHER, Arch. f. Ohren-, Nasen- u. Kehlkopfh. **140**:355, 1936.

Lüscher says that in 1926 Steinmann called attention to a peculiar aspect of the tympanic membrane in mastoiditis which is ripe for operation. He pointed out that the mastoiditic tympanic membrane is characterized by a pale red as compared with the bright red hyperemia in acute, uncomplicated otitis media. Lüscher shows that otomicroscopic examination by means of his otomicroscope corroborates and further clarifies Steinmann's observations, for a tenfold to twentyfold magnification reveals, in addition to the characteristic color, several other typical changes. He elucidates these on the basis of three case reports with illustrations. He reaches the conclusion that the mastoiditic tympanic membrane appears only in some of the cases of empyema of the mastoid and that consequently its absence does not definitely exclude mastoiditis that is ripe for operation. However, if the changes are present, they indicate not only mastoiditis but also empyema. For this reason, the changes are especially important in latent mastoiditis, for they indicate the necessity of an antrotomy.

EDITOR'S ABSTRACT.

CHANGES IN THE TEMPORAL BONE AFTER POISONING WITH VIOSTEROL: EXPERIMENTS ON RATS. W. KRAINZ, Monatschr. f. Ohrenh. **70**:6 (Jan.) 1936.

In summarizing his observations Krainz says that the administration of increasing quantities of viosterol to young growing rats results in skeletal changes that resemble those of rickets. In the temporal bone, however, there appears increased decomposition as well as enormous apposition (building on) of bone tissue. The decomposition involves also the enchondral labyrinthine capsule; the process of the formation of new bone not only fills the defect that is produced by the decomposition but also, by the apposition of wide, noncalcified seams in the vascular canals, results in their stenosis and, by endosteal proliferation of the bone in the medullary spaces, results in greater density of the bone. This bony apposition (building on of bone) involves the walls of the tympanic cavity as well as the auditory ossicles. The disturbance in the calcium economy of the organism, which is produced by the acidosis of the blood, in the labyrinthine capsule results occasionally in a calcium stasis in the vessels as well as in calcium deposits on the newly formed bone tissues. The predominance of appositional processes in the temporal bone compared with the changes in the other parts of the skeleton as well as the tendency to bony densification indicates a characteristic of the labyrinthine bone, which is probably important in the estimation of its capacity for reaction to experimental irritations and to the effects of acidosis of the blood.

EDITOR'S ABSTRACT.

DRIED VACCINES IN THERAPY OF ACUTE SUPPURATION. H. SCHAEFER, Monatschr. f. Ohrenh. **70**:14 (Jan.) 1936.

In acute suppuration of the middle ear Schaefer tried local treatment with dry vaccines that were prepared from killed bacteria and other substances. He experimented with four different vaccines: staphylococcus vaccine A, streptococcus vaccine B, mixed vaccine C and pus vaccine D, the preparation of all of which he describes. The vaccines were administered after careful cleansing of the auditory meatus. A small amount of the dry vaccine was blown into the meatus by means of a powder blower and under moderate pressure. The aim was to cover the entire surface of the tympanic membrane by a thin layer of vaccine. The application was made once every day or at intervals of two or more days. The staphylococcus vaccine was used in five cases and was successful in one. The streptococcus vaccine was tried in only one case, in which it failed. However, on account of several unexpected complications, this case is not suited for use as a basis of evaluation. The mixed vaccine was used in four cases and proved effective in two. The pus vaccine was effective in two of three cases.

The author concedes that the limited number of his observations permits no definite evaluation of the treatment, but he thinks that further trials are justified, particularly with the pus vaccine in suppurating lesions, and that the method might perhaps be further improved.

EDITOR'S ABSTRACT.

THE CLINICAL CONDITION OF THE INTERNAL EAR IN MÉNIÈRE'S SYNDROME. M. D. EISENBERG, Monatschr. f. Ohrenh. **70**:22 (Jan.) 1936.

Eisenberg, after citing the opinions of different authors regarding the underlying pathologic process in Ménière's disease, designates as the aim of his own investigations the examination and clarification of the vestibular and cochlear function of patients in whom neuropathologists had detected Ménière's syndrome. There were thirty-three patients, sixteen men and seventeen women. The anamnesis was taken, and the ears, nose and throat were examined. Then the patient was subjected to the Weber, Rinne and Schwabach tests. The cochlea was tested by means of several tones and the whispering voice. Then followed Romberg's test, walking with the head erect and the eyes closed, the spontaneous nystagmus, spontaneous past pointing, spontaneous deviation of the outstretched hands, rotatory and caloric tests and examination of the otolithic reaction.

In summarizing the results of his observations, Eisenberg says that he observed a varied etiology. In many cases he observed angioneurotic factors, with dysfunction of some systems (endocrine disorders, intestinal intoxication and, particularly in women, disorders of the genitals). The capacity for hearing was impaired in most cases. However, this impairment is frequently only temporary and disappears after the attack. Disturbance in walking, with an inclination to the diseased side, was noticeable in half of the cases. Spontaneous nystagmus was rarely observed, probably because the observations were not made during the attacks. The functional disturbances of the semicircular canals were frequent and characteristic. The otolithic reaction is not characteristic and frequently does not correspond to the condition of the semicircular canals. The reaction to the pointing test likewise is not characteristic. Spontaneous deviation of the hands to the side of the diseased labyrinth and asymmetry of these manifestations following rotation and calorization as well as sympathetic disturbances following irritation of the labyrinth and of the otolithic apparatus are rather frequent.

Eisenberg concludes that, according to the clinical aspects of Ménière's syndrome, its basis is a structural change in the neural apparatus of the internal ear. It is not a definite nosologic unit but may be elicited in various diseases (syphilis, leukemia, infectious diseases, gout, arteriosclerosis and others). However, since the direct cause is not definitely known as yet (perhaps angioneurosis), further studies on its relation to disturbances in the endocrine system, in the metabolism or in other systems are advisable.

EDITOR'S ABSTRACT.

LAW OF SYMMETRY IN HEREDITARY DEAFNESS. B. LANGENBECK, Ztschr. f. Hals-, Nasen- u. Ohrenh. **39**:223, 1936.

The examination of sixty-one deaf-mutes revealed to Langenbeck that the majority of those in whom the condition is apparently hereditary present typical changes of the organ of hearing. The vestibular apparatus can be stimulated on both sides, and tests with the oto-audion reveal entirely identical remnants of hearing in the two ears. In a smaller group of patients, although the vestibular apparatus responds to stimulus, neither ear has any remnant of hearing. In a third, still smaller group, with retention of vestibular stimulability, the remnants of hearing are largely identical in the two ears, but, particularly in the lower and middle frequencies, there are deviations, which, however, can be explained by former inflammatory disorders. This third group is really a modification of the first one. All three groups, however, can be regarded as the manifestation of a law, which the author designates as the law of symmetry of hereditary deafness, because the changes are symmetrical in the two ears. He emphasizes that the tests

of hearing should be made with the oto-audion rather than with the tuning fork. He states further that tests on normal persons revealed as a rule completely identical curves for the hearing of the two ears, and he thinks that this makes the law of symmetry in hereditary deafness even more probable. Similar observations in other spheres make it probable that beyond this law of symmetry of hereditary deafness there is a more general law of symmetry of hereditary disorders.

The comparatively rare exceptions to the law of symmetry of hereditary deafness are probably explainable by the intermediate hereditary transmission of two types of hereditary deafness from the parents to the children. The child may have the same intermediate type in both ears, or he may have the paternal type of deafness in one ear and the maternal type in the other. The author thinks that the law of symmetry is the best criterion of the hereditary character of deafness and that for this reason it is highly important in the enforcement of the law for the prevention of defective offspring. EDITOR'S ABSTRACT.

Pharynx

OUTSTANDING ADVANTAGES OF SHORT WAVE DIATHERMY IN THE COAGULATION OF TONSILS. WILLIAM A. GROSS, M. Rec. **143**:207 (March 4) 1936.

Short wave diathermy has resulted in more ease and practicability of application by reason of the use of a blunt electrode and treatment by surface application. Coagulation is practically instantaneous and is easily controlled, and the time required per treatment is materially lessened because of the rapidity of action. Usually the indifferent pole may be dispensed with. The danger of bleeding is markedly lessened. The procedure appears simple to the patient.

WILLIAMSON, New Orleans. [AM. J. DIS. CHILD.]

MULTIPLE PARALYSIS OF THE CRANIAL NERVES DUE TO EXTENSION OF RHINOPHARYNGEAL TUMORS TO THE BASE OF THE SKULL. H. ROGER and J. PAILLAS, Rev. d'oto-neuro-opht. **13**:165 (March) 1935.

Tumors of the pharynx are divided into two classes (Jacod): those that develop at the expense of the vault and those that invade the lateral wall. Tumors of the first class develop in the nasopharyngeal, nasal and sinus cavities and affect only the branches of the cranial nerves, without invading the endocranial cavity except by extension through the sphenoid and ethmoid cavities. Tumors of the second class extend to the cranial base along the peritubal aponeurotic fascias, through the anterior lacerated foramen; the floor of the middle fossa is penetrated in the zone of the petrosphenoid bone, and the tumor extends under the dura, involving the third, fourth, fifth and sixth cranial nerves. Rarely does it extend over the petrous ridge to the internal auditory meatus and involve the seventh and eighth nerves. Less rarely the extension is toward the median line, involving the posterior lacerated foramen and the hypoglossal canal and causing paralysis of the last four cranial nerves.

Metastatic propagation is by means of blood or lymph vessels or the nerve sheaths. Endocranial metastasis by way of the vessels is unknown; the course of metastases of this type is along the nerve sheaths. Propagation through lymphatic channels reaches the retropharyngeal nodes or the superior ganglions of the internal jugular chain. Metastases to the ganglions in the region of the posterior lacerated foramen affect the ninth, tenth and eleventh nerves and sometimes the twelfth nerve.

In the majority of cases the symptoms begin with headache or facial neuralgia. Headache is usually in the vertex and is not ameliorated by the usual anodynes. Facial neuralgia is often the only early symptom. It occurs in paroxysms, and the three branches of the nerve are successively involved, the ophthalmic branch

being affected last. It is accompanied by hypesthesia. In typical cases the triad of symptoms consists of neuralgia, hypo-acusis and homolateral strabismus. Modifications of the cerebrospinal fluid are indefinite or absent, owing to the fact that the dura is rarely penetrated and to spontaneous decompression. When papillary stasis exists, it is caused by edema in the pericancerous tissues. The fluid may contain a little albumin and a few cellular elements. Roentgenography is an important aid in the diagnosis, and plates should be made from many angles. It reveals evidence of absorption of bone and sometimes a shadow of the tumor itself. Evolution is progressive and is followed, step by step, by successive paralysis of the cranial nerves. Cachexia develops, and death occurs, usually from bulbar syncope.

The clinical syndromes are composed of certain anomalous forms and the following classic syndromes: (1) syndrome of the petrosphenoid cross-roads, with association of unilateral paralysis of the second, third, fourth fifth and sixth nerves, facial neuralgia, total unilateral ophthalmoplegia and amaurosis; (2) syndrome of the point of the petrous bone, comprising paralysis of the trigeminal nerve and the external rectus muscle; (3) syndrome of the posterior lacerated foramen, characterized by paralysis of the ninth, tenth and eleventh nerves, "sign of the curtain," absence of taste over the posterior third of the tongue, sensory disturbances of the velopharyngolaryngeal mucosa, a cough like pertussis, that of modification of the salivary secretion, paralysis of the trapezius and the sternocleidomastoid muscle and hemiparalysis of the velum and larynx; (4) syndrome of the jugulohypoglossal canal, characterized by the syndrome of Vernet, paralysis of the hypoglossal nerve and lingual hemiatrophy, with deviation of the point of the tongue to the normal side while the tongue is in the mouth and to the opposite side when it is protruded, and (5) unilateral paralytic global syndrome of the cranial nerves.

The anomalous forms are: (1) syndromes in which the continuity of the paralytic progression is broken by the integrity of certain nerves and (2) syndromes in which there are bilateral lesions. In the first group the extension of the growth is irregular, or certain nerves offer better resistance to the encroachment of the tumor. In some cases in the second group involvement of the motor nerves of the eye (the sixth especially) is exhibited, owing to destruction of the sella turcica, and in other cases there is early development of cancerous meningitis or metastasis, involving distant nerve structures, the so-called neutrophilic cancer.

DENNIS, San Diego, Calif. [ARCH. NEUROL. & PSYCHIAT.]

TRANSITORY PASSAGE OF BACTERIA INTO THE BLOOD STREAM FOLLOWING TONSILLECTOMY. J. FISCHER and F. GOTTDENKER, Monatschr. f. Ohrenh. **69**:1420 (Dec.) 1935.

Fischer and Gottdenker made bacteriologic tests on the blood of sixty-six patients, fifty-one of whom underwent tonsillectomy and fifteen of whom underwent antrotomy, resection of the septum, the Caldwell-Luc operation and similar treatment. The specimens of blood were withdrawn before, immediately after, two hours after and twenty-four hours after the operation. Positive results were obtained for sixteen of the fifty-one patients who underwent tonsillectomy and for one of the fifteen patients of the second group. Most of the positive results were obtained in the specimens that were withdrawn two hours after the operation. The authors emphasize that the appearance of bacteremia is not identical with septicemia or septicopyemia but that the bacteria enter the blood stream only temporarily, without causing symptoms. To be sure, in case of a predisposition or in case of reduced resistance of the organism, it is possible that the bacteria which invade the blood stream after tonsillectomy, may cause a flare-up of an old or a latent process.

EDITOR'S ABSTRACT.

Nose

MALIGNANT TUMOR OF ETHMO-ORBITAL REGION. H. BRUNNER, Monatschr. f. Ohrenh. **70**:129 (Feb.) 1936.

Among nine cases of malignant tumor of the accessory nasal sinuses which Brunner has observed since 1932 there were three which he considers of especial interest. These three had in common a disease process in the ethmo-orbital region, and in two there existed a sarcoma, whereas in the third it could not be definitely determined whether a sarcoma or a carcinoma existed. The author gives detailed reports of these cases.

The first patient had had frequent attacks of headache and of pain in the region of the right eye for twenty years before the appearance of the symptoms of tumor. On the basis of the entire clinical course, it is possible that these complaints were caused by the tumor, which would indicate an extremely slow growth. To be sure, in view of Kundrat's emphasis on the slow growth of tumors of the ethmo-orbital region this does not seem unlikely. About two years before death definite symptoms of tumor appeared, and the author considers it noteworthy that these were not nasal symptoms but rather ocular symptoms. The ophthalmologist thought of a retrobulbar process but assumed it to be of an inflammatory character (neuritis retrobulbaris). He urged opening of the accessory sinuses on the right side, but no indications were found of an inflammatory or a neoplastic process. Subsequently the ethmoid and the sphenoid sinus were opened, but with the exception of a narrow fistula in the ethmoid (probably a connection between the sinus and the orbit that was caused by the tumor) both cavities were normal. This intervention did not improve the patient's vision; on the contrary, it seemed that it resulted in an accelerated growth of the tumor. Nevertheless, the patient survived the first appearance of the symptoms of tumor for two years. The necropsy disclosed an osteoid sarcoma, which had become interspersed into the right half of the anterior and the middle cranial fossa and which had destroyed a portion of the basis of the frontal lobe.

In a discussion of the second case history, Brunner emphasized that in this case likewise the ocular symptoms appeared long before the nasal ones. A tumor of the ethmoid sinus was thought of, and a sarcoma of Ewing's type was detected. Roentgen irradiation apparently resulted in complete disappearance of the tumor, but two months later new symptoms appeared and tumor tissue appeared in the nose. Several months later a tumor was discovered in the breast. The examination of the tumor, after amputation of the breast, revealed a carcinoma and metastases on the lymph nodes. A comparison of this tumor with the structure of the tumor particles that at the first intervention had been removed from the maxillary sinus, revealed identity, but no agreement could be reached as to whether the primary tumor had been in the ethmoid sinus or in the mammary gland.

The third case differs from the first two in that the first symptoms of tumor were hemorrhages from the nose rather than ocular symptoms. In the last part of his report the author discusses the therapy of such tumors.

EDITOR'S ABSTRACT.

CORRECTION OF DEPRESSED BRIDGE AND FLATTENED TIP OF THE NOSE BY MEANS OF AN IVORY PROSTHESIS. G. CLAUS, Ztschr. f. Laryng., Rhin., Otol. (Teil 1: Folia oto-laryng.) **26**:431, 1936.

After mentioning several other reports on the use of ivory for plastic operations on the nose, Claus points out that ivory is suited not only for the correction of depressions in the bridge of the nose but also for pushing forward a flattened tip. He reports the case of a woman aged 27 who had sustained a nasal trauma during childhood. At the root of the nose she had a considerable lump formation, and below it the nasal bridge was depressed and the tip of the nose was drawn backward to a considerable extent. The septal cartilage was absent, and the bony septum was partly gone. By removing the lump the nose would have

been made extremely wide, the tip of the nose would have fallen back still farther and a flat nose would have been the result. For this reason it was decided to lift the nasal tip by the introduction of an ivory prosthesis.

The author describes how a one piece profile prosthesis was prepared and how the plastic operation was made. The patient's recovery was uneventful. At first there was a feeling of tension in the nose, but this soon disappeared, and the final cosmetic result was satisfactory. The author gives photographs showing the preoperative and the postoperative appearance, as well as a roentgenogram that was made in order to have a guide for the proper modeling of the prosthesis and the roentgenogram that shows the form and position of the prosthesis.

EDITOR'S ABSTRACT.

Miscellaneous

AGRANULOCYTIC ANGINA (REPORT OF TWO CASES IN CHILDREN). P. L. PÉROT, New Orleans M. & S. J. **88**:500 (Feb.) 1936.

The cases of two children with agranulocytic angina, aged 3½ and 6 years, respectively, are reported. Clinically, the condition was characterized by high fever, severe cervical adenitis and membranous pharyngitis with a foul odor. Both cases were fatal. No autopsies are reported.

The diagnosis of agranulocytic angina in these cases seems highly questionable on the basis of the blood counts reported. Examination of the blood of the first patient showed a white cell count of 1,500, with 10 per cent granular cells. Examination of the blood of the second patient showed a white cell count of 1,600, with 12 per cent granular cells. Neither the granulocyte nor the leukocyte count was sufficiently low to account for the lesions in the mouth.

The reviewer believes that infection has not been ruled out and that lymphatic leukemia is the more probable diagnosis.

BERKELEY, Los Angeles. [AM. J. DIS. CHILD.]

NEW CASE OF COMPLETE ANOSMIA AND AGEUSIA OF TRAUMATIC ORIGIN. J. HELSMOORTL JR., R. NYSSES and R. THIENPONT, J. belge de neurol. et de psychiat. **35**:656 (Nov.) 1935.

Nysses and Thienpont state that real ageusia is rare in posttraumatic conditions. complete ageusia is usually of central origin and may occur as a unilateral phenomenon associated with certain types of hemiplegia. Also, it has been noted after intracranial section of the fifth nerve and may be associated with diminution of somatic sensation. It may occur also in hysteria. The authors review the theory of the mechanism of gustatory impressions by Kleist, in which it is stated that such impressions are transmitted by the chorda tympani nerve and the nervus intermedius to the anterior two thirds of the tongue and by the glossopharyngeal and possibly part of the vagus nerve to the posterior part of the tongue. The bulbar center for taste is constituted principally by the dorsolateral nucleus of the glossopharyngeal nerve. The central pathway for taste ascends, after partially crossing in the region of the pons, and ends in the anterolateral nucleus or the median nucleus of the thalamus, near the trigeminal zone. From there the gustatory path proceeds through the posterior part of the internal capsule to the inferior part of the central convolution, where presumably the gustatory center coincides with the subcentral area. It is stated that this localization is confirmed in cases of traumatic lesion. According to other authors, the cortical center for taste is in the hippocampal convolution near the uncinate gyrus, associated closely with the olfactory center. It is stated that in true anosmia there persists a partial perception of irritant odors, which suggests that the absence of perception of irritating odors is strongly in favor of a diagnosis of hysteria or malingering. In the cases described pyridine and ether were perceived while chloroform and alcohol were not. This suggested to the authors that the condition was of organic origin.

WAGGONER, Ann Arbor, Mich. [ARCH. NEUROL. & PSYCHIAT.]

Directory of Otolaryngologic Societies *

FOREIGN

Collegium Oto-Rhino-Laryngologicum Amicitiæ Sacrum

President: Prof. Gunnar Holmgren, Karolinska Mediko-Kirurgiska Institutet, Stockholm, Sweden.
Secretary: Prof. Dr. C. E. Benjamins, Verlengde Heereweg, 143 Groningen, The Netherlands.

NATIONAL

American Medical Association, Scientific Assembly, Section on Laryngology, Otology and Rhinology

Chairman: Dr. Robert F. Ridpath, 1737 Chestnut St., Philadelphia.
Secretary: Dr. Gordon B. New, Mayo Clinic, Rochester, Minn.
Place: Atlantic City, N. J. Time: June 7-11, 1937.

American Academy of Ophthalmology and Otolaryngology

President: Dr. Frank E. Burch, 408 Peter St., St. Paul.
Executive Secretary: Dr. William P. Wherry, 1500 Medical Arts Bldg., Omaha.
Place: Palmer House, Chicago. Time: Oct. 10-15, 1937.

American Bronchoscopic Society

President: Dr. Joseph C. Beck, 185 N. Wabash Ave., Chicago.
Secretary: Dr. Lyman Richards, 319 Longwood Ave., Boston.
Place: Atlantic City, N. J. Time: June 2, 1937.

American Laryngological Association

President: Dr. W. B. Chamberlain, 10515 Carnegie Ave., Cleveland.
Secretary: Dr. James A. Babbitt, 1912 Spruce St., Philadelphia.
Place: Atlantic City, N. J. Time: May 31 and June 1-2, 1937.

American Laryngological, Rhinological and Otological Society, Inc.

President: Dr. George M. Coates, 1721 Pine St., Philadelphia.
Secretary: Dr. C. Stewart Nash, 708 Medical Arts Bldg., Rochester, N. Y.
Place: Hotel Traymore, Atlantic City, N. J. Time: June 3, 4 and 5, 1937.

SECTIONS:

Eastern.—Chairman: Dr. D. C. Jarvis, Quarry Bank Bldg., Barre, Vt.
Southern.—Chairman: Dr. Charles D. Blassingame, P. & S. Bldg., Memphis, Tenn.
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American Otological Society

President: Dr. Edmund Prince Fowler, 140 E. 54th St., New York.
Secretary: Dr. Thomas J. Harris, 104 E. 40th St., New York.
Place: Lido Club, Long Beach, N. Y.: Time: May 27-28, 1937.

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* Secretaries of societies are requested to furnish the information necessary to keep this list up to date.